ENGINEERING NEWS.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

VOL. XXIII. No. 1.

TABLE OF CONTENTS.

Engineering News of the Week 1, 2

Technical and Illustrated Articles

Performance of the Best Modern Pumping Engines Compared to that of the Cornish Pumping Engines in 1840 (*Continued*) 2
The Toronto Esplanade Question 4
The Brooklyn Bridge Terminals 6
Head-Gates and Booms of Main Canal, Dolores, Col., (*With Inset*) 7
The Sault Ste. Marie Canal 7
Foundations of Northeast and Southwest Quays of the Outer Harbor of Calais, France 7
A Wrought-Iron Turntable, Half-Through Type ... 9
Municipal Monopolies 9
The Use of Dynamite at the Johnstown Drift Dam. 17
The Effect of Acting on Good Advice 18
Irrigation in Idaho 18
Scientific Progress in 1889 19
A Manual of Railway Field-Work (*Continued*) 19
The Railway Construction of 1889 20

Publications Received, Trade Publications, Society Proceedings 10, 11

Editorials and Editorial Notes 12, 13

The Last Decade of the Nineteenth Century.—Progress of Engineering and of Engineering Journals.—The Street Cleaning Department of New York City.—Political Favoritism the Chief Foe to Clean Streets.—The Engineers' Club of Philadelphia and its Approaching Election.—The Proposed Bureau of Harbors and Water-Ways.—Is the Gulf Stream Responsible for the Mild Winter?

New York City's Rapid Transit Facilities 13
M. C. B. and Other Automatic Couplers 14

Correspondence 16, 17

M. C. B. and Other Automatic Couplers.—Cornell for the Next Am. Soc. C. E. Convention.—Six-Place Logarithmic Tables.—Formulæ vs. Formulas.—Notes and Queries.

Personals 17

Railways, Rapid Transit, Highways, Contracting, Proposals Open, Manufacturing and Technical, Bridges and Canals, Electrical, Sewerage and Municipal, Water-Works ..... 20—24

ENGINEERING NEWS.

THE HUDSON RIVER TUNNEL, according to the report at its last annual meeting, is to be hereafter worked by the Greathead shield system. The entire distance excavated at the New Jersey end is now 2050 ft., with about 300 ft. done at the New York end. The total length of the tunnel will be about 5,600 ft. with approaches about three-quarters of a mile long at each end. The chief change in plan will be to substitute for the 2 ft. brick shell a 2½ in. cast-iron shell with a thinner brick lining inside. The diameter of this new tunnel will be about 20 ft., instead of 16½ x 18½ ft., the present dimensions. Since the issue by the English company of $1,500,000 first mortgage 6 per cent. bonds, about 400 ft. of tunnel have been finished. The Greathead system of tunnelling is the same as that used in driving the Thames subway, now practically completed, and fully described in this journal last year. The engineers expect to build 15 ft. per day with this shield. S. PEARSON & SON of Westminster, England, are the contractors.

A NEW PROCESS OF PREPARING FOUNDATIONS has been patented by F. NEUKIRCH, of Bremen. Its object is to make loose sand firm and resisting as solid rock. At present, the universal method of doing this work, if under water, is to remove all loose material and then make a beton or other similar substructure. The process under consideration, which is only of use where the materials are fairly clean silicious or calcareous sand, aims at consolidating the grains by covering them with a film of cement, which is forced into the spaces between the particles by compressed air, steam, or water under pressure. Sheet piles are employed to prevent the spreading of the cement over more ground than is necessary. The system has been largely used in the harbor of Bremen with gratifying results and is to be tried in preparing dry foundations.

A CUBAN TORPEDO BOAT, the *Peral*, had a very successful trial on Dec. 17, in the Bay of Cadiz. The boat was submerged, leaving nothing out of water but the observation turret. After four hours she was sunk further, till only one-half of the turret remained above water. Evolutions were performed with the boat at this depth, and a considerable distance was traversed in the bay for three hours more, when she returned to the arsenal. The results as far as navigation is concerned, were entirely satisfactory. During these evolutions for one and one-half hours the *Peral* was entirely submerged and to a considerable depth.

In previous trials the boat left the arsenal in the morning, and after traversing seven miles of the bay and reaching the open sea commenced submerging operations. On this occasion the trial was limited to two total immersions, one of six minutes and the other of eight. For more than three hours the *Peral* performed evolutions submerged to the extent that only 20 ins. of the observation turret was above the surface of the water. The boat is operated by electricity supplied by storage batteries.

THE UNITED STATES ORDNANCE DEPARTMENT is about to establish a testing ground and butts in connection with the West Troy (Watervliet) gun foundry. Col. WM. H. SLINGERLAND, of the firm of Slingerland & Son, of Albany, N. Y., has been appointed to contract for the purchase of several tracts of land for test ground, most of which, we are informed, has already been contracted for by him.

A DECISION OF INTEREST TO RAILWAY CONSTRUCTION COMPANIES was rendered last week at Hudson, N. Y. Cameron & Clark, the contractors for grading and bridging on the Kinderhook & Hudson Railroad, were paid about $10,000 recently for work thus far done. Instead of using it to pay their employees, one of the firm pocketed the money and started for Canada; but before he reached the border, he was arrested and brought back on the charge of grand larceny. On the preliminary examination, however, the Court ordered his discharge; for it was proven that nothing was said about the use of the money to pay the laborers when the check was obtained, although the railroad officials supposed it was to be applied to this purpose. The Court therefore held that no crime had been committed within the meaning of the statute. The contractors had given no bond for the faithful performance of their work, and the railroad company will have to resort to civil proceedings to recover their money.

THE MOST SERIOUS RAILWAY ACCIDENT of the week, and one of the most serious that has occurred for some time, was the derailment, on Dec. 28, of the vestibuled through express on the Chesapeake & Ohio Railway between Caldwell and White Sulphur Springs, W. Va. The accident was caused by a broken rail or defective track; one reports states that the rails were badly worn and the ties rotten. The train was composed of seven cars, six of which were thrown down a high embankment. The entire train except the engine left the track. The first car telescoped the smoker, killing every occupant of the latter car except one and demolishing the car entirely, all on the first car escaping. Luckily the cars did not take fire, they being heated by steam, and we may add, not lighted with gasoline. The engine did not leave the rails, but the tender was without any trucks. The rear sleeper had its front trucks on the ground, and remained on the rails. There were ten persons killed and about a dozen injured. This accident points out very forcibly one of the gravest defects of our railway systems: large sums of money are spent in the construction and decoration of elaborate and luxurious rolling stock, while expenditures on the track which is to carry this rolling stock are made grudgingly. There are many places where similar accidents to the above are liable to occur, and it is to be hoped that improvements will be made before an accident calls attention to the need.

A HEAD COLLISION between a passenger and freight train occurred on the Chesapeake & Ohio Railway, near Pemberton, Va., Dec. 27. The accident was the result of a misunderstanding of orders. The passenger train was badly wrecked, and some of the cars were thrown down the bank. Two persons were injured.——A Baltimore & Ohio express train was derailed at Dickerson's, Md., last week, by striking a horse on the track. The engine and tender went down a 70-ft. bank, and the engineer was killed; three or four persons were injured. In view of several accidents of this kind it would seem that a more efficient form of cow-catcher or pilot is needed, or that the railways should be fenced in. ——A car of a Philadelphia & Reading train which was just leaving Philadelphia, Dec. 29, was overturned and caught fire; men at work in the yards put out the fire; the passenger were bruised and cut by broken glass.

THE BOILER OF A LOCOMOTIVE on the New Jersey Central Railroad exploded Dec. 24, while standing at Matawan Junction. The engineer and fireman were thrown to some distance but were not seriously injured.

BRIDGE ACCIDENTS are reported as follows: the completed span of the new Maynard St. bridge over the Susquehanna at Williamsport, Pa., was blown down Dec. 27 by a heavy wind storm. The bridge was to replace the structure destroyed by the floods last June. The draw of the Arthur Kill Bridge of the Baltimore & Ohio Railroad, connecting Staten Island with the Jersey shore, was closed with such force by the high wind on Dec. 26 as to break some of the gearing of the machinery.—A bridge being erected across the Lehigh River between Lehighton and Weissport, Pa., was blown down Dec. 26. Three men were injured.

THE OLD PENNSYLVANIA CANAL, that has been in service for sixty years, is now practically abandoned and its bed is to be used by the Pennsylvania Railroad. This road owns the canal and is at work destroying the old aqueducts, bridges, etc., and is straightening out its line in many places by using the canal bed. Portions of the canal were in use up to the present year.

GRADE CROSSINGS IN CHICAGO, in 1889, caused the deaths of 260 persons, says the Coroner of that city. The record for the last four years is over 1,000 deaths. The cause given is too great speed in trains, which speed is said to often exceed 20 to 25 miles per hour within the city limits.

A NEW AUTOMATIC BLOCK SYSTEM possessing features of great merit under special conditions, is being introduced on the New York Elevated lines, the Manhattan Railroad Company having adopted it for all its lines. It is the invention of Roadmaster ROBERT BLACK. Its method of operation is very simple, and if engineers keep on the watch for the semaphores, as they indicate "safety" or "danger," it is impossible to run trains together. A jointed bar

runs along the side of the rails and connects with bars attached to the signals, which are situated at given distances from each other. When a train passes one of these signals the tread of the wheels presses the bar down and causes the signal to set automatically at "danger." When the train passes the next signal it sets the semaphore also at "danger" and at the same time causes the semaphore of the preceding signal to fall to the position of "safety." By the use of this system a train passing a signal always leaves danger behind it and at the same time leaves the track clear at the second signal back. The Eighth Avenue line from 59th to 116th St. is now equipped with it, and during the several heavy fogs prevailing of late it has been found a great aid to safe and rapid operation.

BOSTON, MASS., does not approve of the wholesale removal of electric light and power wires now going on in New York. The journals of that city wisely trust that the experience here will not be lost on other cities, and that when these cities do go about burying the high tension wire, they will first see to it that the system adopted is thorough and reliable from the start. The hint is thrown out that simply cutting the wires in New York would have been perhaps less theatrical than hewing down poles and removing them and the wires; but it would have been quite as efficient in preventing loss of life.

THE CHARLES RIVER BRIDGE item, in our last issue, needs a little explanation, writes Mr. L. M. HASTINGS, City Engineer of Cambridge, Mass. Regarding our statement that "The City Engineer estimated the cost of the bridge at $137,500, and the railroad company offered to do the same and necessary filling for $75,000," Mr. HASTINGS writes that his estimate was for 110,000 cu. yds. of filling, building abutments and a plate girder bridge over the B. & A. R. R. track. The railroad company being directly interested in securing a separation of grades, offered to do the same work for $75,000; but were careful to state that that was not their "price" for doing similar work.

THE PHILADELPHIA & READING RAILROAD can have a terminal at Broad and Arch Streets, under certain conditions, say the Councilmen of Philadelphia. But the railroad company wants to go to Market Street and will approve no other plan. So the fight goes merrily on.

THE RAPID TRANSIT CABLE COMPANY, of New York, is said to be planning an elevated railway for Broadway in this city, with the cable system of this company provided as a high speed motor for trains.

THE FERRY BRIDGES that have so long and well performed the duty of transferring millions to the boats on the Hudson and East Rivers bounding this city, are claimed as the invention of Mayor HALE, of Plainfield, N. J. They are most efficient bridges, whoever invented them.

THE CHIGNECTO SHIP RAILWAY, according to the latest report, is to be completed early next spring. The entrance works are well advanced and the roadbed is ready for tracklaying. The rails are to weigh 110 lb. per yard. The tariff for lifting and hauling vessels will be 50 cts. per ton for cargo and 25 cts. per ton for the hull.

SECOND-HAND RAILS, especially rails weighing from 35 to 40 lbs. per yd., are wanted by several of our correspondents. Parties having rails to sell suitable for light traffic can find buyers by addressing this office.

IMMIGRATION continues to increase, unhappily. For the month of November the totals are:

For 1888	25,419
For 1889	29,097

For the eleven months ending with November, on the contrary, the totals are:

For 1888	498,591
For 1889	407,237

At the rate at which immigration was running at the end of 1889, that year should have shown nearly 600,000 immigrants, which would have been the largest on record except during the three years 1881-3, which averaged 687,000 each, the five previous years having averaged but little over 150,000.

Performance of the Best Modern Pumping Engines, compared to that of the Cornish Pumping Engines in the Period of 1840.

By Prof. J. E. DENTON, Stevens Inst. of Technology.*

(Continued from Page 605.)

Referring to Table II, the determinations cover five ratios of expansion as per Col. (5), varying from 1.6 to 2.9. The mean effective pressure Col. (8) was made constant by pumping against a constant head. Hence the boiler pressure Col. (2) and pressure of admission Col. (3) increased as the cut-off was decreased.

The water consumption Col. (10) was determined by weighing the feed water supplied to the boilers during the time of the experiments, which, as per Col. (1), averaged over 100 hours. The water consumption includes the steam supplied to the jackets. The condensed water from the jackets was returned to the boilers by gravity. Its amount was determined, by actual weighing, to be 4 per cent. of the total consumption.

The actual boiler evaporation with the best Welsh coal was 9.49 lbs. of water from 100° temperature of feed; and this figure is used in calculating the duty Col. (11). The duty line 5 is given as calculated by WICKSTEED as follows;

Height water is lifted	Area of Plunger	Stroke of Pump	Density of Water	Evaporation per lb. coal	Steam per stroke
ft.	sq. ft.	ft.	lbs.	lbs.	lbs.

$$108 \times 9.168 \times 9 \times 62.5 \times 9.49 \times 100 \div 5.47 = 96{,}600{,}000$$

No allowance for slip or variable stroke is made, WICKSTEED stating that the actual delivery was determined to be theoretically perfect, much labor and expense having been expended in improving the water valves so that this perfect action was obtained. It is difficult to conceive that absolutely no slip or variation of stroke occurred. It appears that by actual weighings, by WICKSTEED and others, of the delivery of other engines in Cornwall the actual delivery was about 90 per cent. of the theoretical. It is reasonable to expect that an improvement in water valves would considerably improve the efficiency of the delivery; but since WICKSTEED *does not claim to have weighed the water during these particular experiments*, it is not unlikely that the duties given are two or three per cent. too high. The indicated horse power is derived by the aid of the following summary of the resistances of the engine:

	lbs. per sq. in. of Steam Piston
Preponderating weight outer end of beam	11.037
Weight of water raised from well into pump barrel	0.821
Feed Pump to boiler	0.037
Air Pump	0.117
Friction of engine mechanism and plunger	0.200
Mean back pressure due to imperfect vacuum	0.730
Total = Gross M. E. P. on Steam Piston	12.94

TABLE 2.—WICKSTEED'S EXPERIMENTS.

On a Cornish Pumping Engine. Bore 80 ins; Stroke 10 ft.; Average Revolutions 6½ per minute. Capacity per 24 hours, 6,000,000 galls. against 108 ft. of head.

Duration of test.	Steam pressure above atmosphere: In boiler	Steam pressure above atmosphere: Average during admission	Average vacuum inches	No. of times steam is expanded	Total number of revolutions during test	Average revolutions per minute	Mean effective pressure, pounds per square inch.	Indicated H. P.	Measured amount water consumed per revolution, including jacket consumption	Duty per 100 lbs. of coal, assuming 9.49 lbs. evaporation	Steam per hour per H. P.: Actual, including jacket consumption	Steam per hour per H. P.: Calculated from probable indicator card.	Remarks
ho'rs	lbs.	lbs.							lbs.				
96	15.75	−0.43	29	1.6	—34760	6.03	12.21	112	7.53	70,131,000	24.28	24.74	Slip of pumps 0
144	20.0	+0.80	29	2.0	—63772	7.37	" "	137	6.463	81,775,000	20.85	21.92	Jacket consumption of steam 4%
168	28.0	+2.20	29	2.34	—63456	6.29	" "	117	6.200	85,244,000	20.00	19.40	
154¼	31.0	+3.19	29	2.61	—59445	6.40	" "	118	5.985	88,306,000	19.47	18.45	Friction of mechanism 14½% of I. H P.
117.6	37.0	+4.23	29	2.9	—49802	6.98	" "	129	5.47	96,600,000	17.75	17.40	Clearance 5%

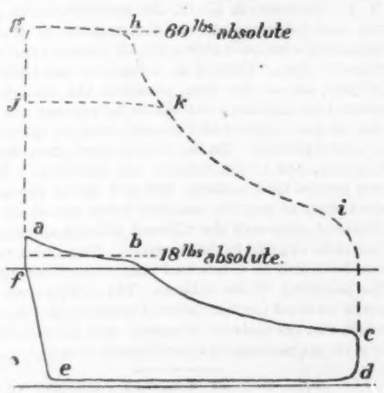


Fig. 2. Effect of Excessive Throttling at Fixed Cut-off.

Subtracting from 12.94 the mean back pressure due to imperfect vacuum, we have 12.21 lbs. per sq. inch as the mean effective pressure which should have been given by an indicator card. No indicator was used; but the cut-off and back pressure due to imperfect vacuum being known, the mean admission pressure can be calculated, and the probable indicator card constructed. Such a calculation gives admission pressures as per Col. (3). It thus appears that the steam entering the cylinders was throttled or wire-drawn over a considerable range of pressure in all the experiments. For the experiment in the lowest line of the table, the throttling reduced the steam from 37 lbs. to 3 lbs. per sq. inch.

Figure (2) shows the effect of such a range of throttling upon the form of the indicator card. Except in the compression line, this figure is a facsimile of cards taken from a small Buckeye Engine by fixing the cut-off at about the same as in the lowest line of Table I. and taking cards on the same paper, first with no throttling, whence the dotted diagram *j k i a c* resulted, and second with throttling sufficient to cause the same mean admission pressure as in the lowest line of the Table; thus obtaining the full-lined diagram *a b c d e*. The compression line is merely sketched, to show the extent of the cushioning that occurred in the Cornish engine under notice. The actual diagram of the Cornish engine would really be made up of two parts as per Figure 3.

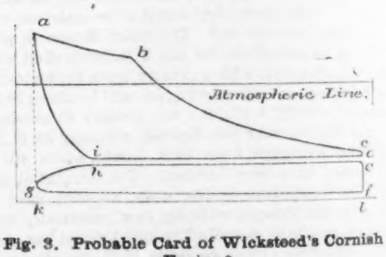


Fig. 3. Probable Card of Wicksteed's Cornish Engine.*

During the downward stroke, steam would act upon the upper side of the piston according to the line *a b c*, while the opposite or under side would have against it simply the vacuum press of *f b*. The work done by the steam would be represented by the area *g a b c f g*. When the working or downward stroke was complete, the equilibrium valve opened and caused steam connection between both

* From a lecture delivered before the New England Water-Works Association during their convention at Fall River, June, 1889.

* A copy of a Cornish engine card taken at St. Louis is given in Prof. Smith's work on Steam Using and also in report on Pumping Engines by Messrs. Graff, Smith, Copeland and Worthen, 1890. The loss of area between cylinders is derived from these cards.

sides of the piston, the valve to the condenser remaining closed. There would therefore be a drop of pressure at C due to the expansion of the cylinder full of steam, to fill the volume in the passage leading to the lower side of the piston. Such expansion in the present instance would make the drop $c\ d$ equal to ⅝ lbs. There would also be a loss of pressure between the two sides of the piston equal to $d\ e = ⅜$ lbs. As, therefore, the piston makes the up stroke, the line of pressure on the upper side of piston is $d\ i$ and on the lower $e\ h$. At i and h the equilibrium valve closed and the exhaust valve to the condenser opened, but the admission valve remained closed up to the end of the stroke, consequently the steam was cushioned to practically admission pressure along $i\ a$. The network of the steam is represented by the sum of the areas $i\ a\ b\ c\ d$ and $e\ h\ g\ f$.

By placing this sum equal to the constant mean effective pressure 12.21 lbs., Col. (8) of Table I, RANKINE in 1851 computed the admission pressures in Col. (3) and computed the weight of steam which should have been used per revolution. I have given the result * of his calculations in water per hour per H. P. in Col. 13.

These figures for the water per H. P. introduce the most remarkable feature of the WICKSTEED experiments to the modern student of steam; for it will be seen that the actual steam used, as determined by measurement Col. (12), is no greater than the calculated amount. In other words, there was no loss by cylinder condensation in this engine, and consequently it realized the full extent of the economy which the principle of expansion theoretically affords. Now, no engine since the advent of these Cornish pumps has succeeded in realizing the full economy promised by the expansive principle. On the contrary, as soon as this principle came to be applied in rotative engines—which began to be generally used during the same period as that which witnessed the high duties performed by the Cornish pumps—it quickly became evident that to use expansion to the extent practised in Cornwall was to reduce rather than to increase the economy.

This fact has never been better illustrated than by the experiment on the steam consumption of the steamer *Michigan*, at various rates of expansion, as determined by Mr. B. F. ISHERWOOD in 1860. These are shown in Table III.

TABLE III.

Engine 30 ins., dia. 8 ft. stroke.

Ratio of expansion, including clearance	1.03	1½	2.9	3¼	4½
Boiler press, above atm	20.1	18.6	19.7	19.6	19.5
Revolutions per min	20.5	15	13	14	11
Actual steam per hour per H.P. as measured	38	34	34.7	34	37
Steam per hour per H.P.,† according to law of expan. or as calculated from the indicator card	34	30	21.0†	19.0	17½

At 2.9 expansions the discrepancy between the steam as calculated and as measured is nearly equal to 75 per cent. of the former amount, and greater rates of expansion cause a decrease in economy.

The same kind of discrepancy had shown itself in all classes of steam engine; thus D. K. CLARK noted its occurrence in locomotives, and M. HIRN had found it in his factory engines and published the fact as early as 1851, and later had shown that the presence of the steam jacket did not prevent the steam consumption from largely exceeding that corresponding to the volume of the vapor shown by the indicator card to be present at cut off or release. The cause of the discrepancy was quickly agreed upon by the leading workers with steam to be as follows: When the valve opened to admit steam to the cylinder, the interior surfaces of the latter were at a temperature approaching that of the exhaust pressure, and a portion of the entering steam condensed to hot water, in heating the metallic surfaces. It was apprehended that to heat only a very slight thickness of the metallic surfaces presented by the cylinder and piston head and cylinder barrel, up to cut-off, through the range of temperature due to expansion, would cause the condensation or collapse of as much steam as was not accounted for by the indicator. For example, in the case of 2.9 expansions in Table III, the range of temperature is 56° F., and to condense as much steam as would, in the form of vapor, fill the cylinder to the point of cut-off, would require that only one-tenth of an inch of thickness of metal should be heated, through 56° F. The heat thus lodged in the metal of the cylinder escaped therefrom principally during the exhaust interval, and hence it was nearly† a total loss. The indicator card could not make known the amount of the extra steam which was thus taken from the boiler, because its presence could not sensibly alter the pressure of the steam which is confined in the space within the cylinder at cut-off.

Thus if the space in the cylinder at the point of cut-off is 11.6 cubic feet and we find by the indicator that the steam in this space is at 20 lbs. pressure, we know by the tables of density of steam that 1 lb. of steam should be the weight of the steam in this space. But if one-half a pound of condensed steam were also present, its volume would be to that of the whole space as the area of Fig. 4 is to Fig. 5,

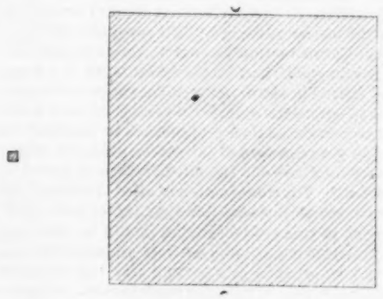


Fig. 4. Fig. 5.

or in round numbers the half pound of condensed steam would occupy 1-1200th of the whole space. Its presence or absence would not affect the pressure of the steam at cut-off and the indicator would not show its amount, nor could the latter be detected in any way except by actually weighing the steam consumption of the engine.

Such was the theory of cylinder condensation as announced by HIRN, CLARK and ISHERWOOD, which apparently placed a limit to the economy to be realized by the principle of expansion.

Yet, as we have seen, the Cornish pumps were not subject to this theory. Why was this? Such was the question asked by engine builders as they came to realize these facts, and competition began to make necessary the study of the refinements of the steam engine, after 1850. JOHN ELDER, of the great marine engine firm of Randolph & Elder, regarded the explanation to be: (1) that the jacket of the Cornish engine contained steam of a higher temperature than that within the cylinder, and (2) that the single-acting feature gave the jacket twice as much time to heat up the cylinder as was the case with the double-acting engine. On this idea he built the jacketed double cylinder or compound engines in which the steam was superheated 150° above the temperature due to saturation, as in the steamships *Callao*, *Bogota*, and *Lima*, which were used on the South American coast in 1859. In his account of these engines (Proceedings Brit. Assoc. Adv. Sci. 1859), ELDER states: "Attention is called to the economy of Cornish pumping engines, in which the jacket has twice the time to act upon the cylinder, available in double-acting engines. I regard the jacket of the larger cylinder of the engines of the *Callao*, etc., as providing extra time for the steam to be under the action of the jacket, and thereby the economical conditions of the Cornish pumps are in a measure realized."

The economy realized by these steamers was notable. Steam of 34 lbs. absolute pressure was used and the rate of expansion was 6½ to 1. The water consumption estimated from the indicator cards was 17 lbs. RANKINE states that the coal per hour per horse power was 2.67* lbs. and that the evaporation of the boilers was 7.24* lbs. of water per pound of coal. This, allowing 12 per cent. for blowing-off boiler, gives a water consumption of 17 lbs. per hour per horse-power. Practically, therefore, ELDER did annul cylinder condensation by copying the jacket conditions of the Cornish or by admitting superheated steam to the jackets. ELDER distinctly states that the use of the superheated steam without the jackets did not destroy cylinder condensation. This is confirmed by the subsequent experiments of HIRN, ISHERWOOD and DIXWELL with superheated steam. The latter will reduce, but will not eliminate, the cylinder condensation, when the range of temperature in the cylinder is upwards of 70° Fahr. We may, therefore, look upon ELDER'S engines as having had practically saturated steam in the cylinders and steam of 150° Fahr. higher temperature in the jackets. Similarly the Cornish pumps, by the superheating effect due to wire-drawing, probably made the steam, at the end of admission, dry steam of 18 lbs. pressure, while the jackets contained steam of 50° higher temperature. Twice in engineering history, therefore, has cylinder condensation been prevented from interfering with the application of the principle of expansion,—once in the Cornish pumps and again by excessive superheating. But such superheating quickly showed itself impracticable because of the injury to boilers thereby. The engines of ELDER were stripped of their superheating attachments after a short period of service, and superheating as an element of steam economy was generally abandoned.

The engineering profession had therefore again before it the problem of discovering a means of preventing the phenomena of cylinder condensation from placing an early limit to the use of high ratios of expansion as a means of securing increased economy. The solution was found in the use of higher boiler pressures and multiple cylinders and greater engine speed. The cylinder condensation is not avoided, but it is reduced in amount per H. P. by means of the following principles:

1. It appears that the principal, in fact almost the entire, loss due to the cylinder condensation is due to the entrance of the extra or condensed steam into the cylinder during admission.

After the consumption is thus increased, the work performed is not much affected by the presence of the condensed steam. In other words, the expansion curves and area of the diagram in both single and compound or multiple engines of ordinary piston speeds are nearly the same† as though the steam remaining vapors at cut-off was expanded without either loss or gain by further condensation‡ in re-evaporation.

2. Hence the problem is really to reduce the condensation during admission only.

3. It was pointed out by RANKINE in discussing the Michigan Experiments (Trans. Inst. of Engineers and Ship-Builders of Scotland, 1860) that the figures for condensation during admission bore the same order as the products of the time of admission and range of temperature and surface to which steam is exposed during admission. Experiments since then on all sizes of engines confirm this deduction. The condensation is not directly proportional to this product, but I find that in a large variety of engines, the condensation per stroke is always less when this product is less.

4. Now consider any given engine which is developing a certain H. P. at a certain boiler pressure, cut-off and speed. By using steam of higher pressure, introduced first into a smaller cylinder, having the same cut-off and speed, and then exhausting into the given cylinder, we can produce the same H. P., and at the same time expose the steam during admission to *less* surface during an equal period of admission, and with no greater range of temperature than in the given cylinder. The ratio of expansion will be increased by the ratio of the vol-

* The figures here used are slightly modified from RANKINE'S as published in Vol. XX. Trans. Royal Society of Edinburgh, the difference being that the expansion line is made to coincide with MARIOTT'S law instead of with an hyperbola of the form $p\ v^{\frac{1}{2}} =$ constant.

†These figures are higher than those in Col. 12 for the same expansion, because the rate of back pressure to initial pressure was less and the loss by clearance was not eliminated in the *Michigan* by compression.

*During the fall of pressure accompanying expansive action some of this heat is saved by the re-evaporation of a portion of the condensed steam, thereby causing the expansive curve to include a greater area. The amount thus saved, however, is very small.

* *London Engineer*, September, 1858.

† It is not intended to ignore the slight gains of area due to re-evaporation.

‡ The writer injected cold water steadily into the steam-pipe of a 7 x 14 non-condensing engine, in amount equal to 20 per cent. of the engine's consumption, with the result that no sensible change occurred in the expansion line, and the increased consumption was simply the water injected plus the steam to heat this water to the boiling temperature.

umes of the two cylinders, but it is found that the cylinder condensation will be no greater *per cent.* of the consumption than with the single cylinder.

5. On the same principle we can proceed to introduce a third cylinder between the boiler and the other two, and by a further elevation of boiler pressure still produce the same H. P. with a greater range of expansion, but no increase in the *per cent.* of cylinder condensation. The result is a less absolute amount of cylinder condensation per H. P. as the ratio of expansion is increased.

Expressed briefly, the modern principle, upon which the loss by cylinder condensation is made to increase more slowly than the gain due to the use of the greater ratio of expansion, is as follows:

Draw steam of the highest possible pressure from the boiler through the *smallest cylinder* which will afford the desired H. P., and use a sufficient number of cylinders to obtain the requisite ratio of expansion, without increasing the range of temperature due to expansion in any one cylinder above the amount giving fair economy with single engines, 70° Fahr.

Other things being equal, the greater the piston speed* the less should be the cylinder condensation, as the time of admission is less.

Other things equal, the less the range† of temperature to which the interior surfaces are exposed, the less the cylinder condensation, as the average temperature of the metallic surfaces is higher. Wire-drawing or throttling the steam during admission tends to reduce cylinder condensation to the extent of the superheating produced, and the latter may be sufficient to annul cylinder condensation entirely, if the range of temperature in the cylinder is sufficiently small.‡

From the standpoint of the foregoing principles and facts, let us consider the conditions of action of the steam in WICKSTEED'S Cornish pumping engine, with the view of determining the true cause of the absence of cylinder condensation.

First, as to Piston Speed.—The interval of one revolution was distributed§ as follows:

Outdoor or upward stroke.....	68½ per cent.
Indoor or working stroke	13¼ " "
Pause at commencement of indoor stroke	18 " "

The average revolutions per minute were 6½, making the time of one revolution 0.154 minute, 13½ per minute of which is 0.02 minute. Consequently the piston speed during the indoor or steam-acting stroke was 500 ft. per minute, or equal to that of the average modern engine. The time factor in the cylinder condensation action was therefore a comparative minimum.

Second, as to Range of Temperature in the Cylinder.—Referring to Fig. 3, it is evident that the piston and cylinder head on the steam-acting end were never relieved of pressure below that corresponding practically to the terminal expansive pressure. The maximum range of temperature is therefore only 32° Fahr., *and the steam-acting end of the cylinder is never in direct connection with the condenser. Hence the two ends of the cylinders act in relation to each other like the two cylinders of a compound engine so far as the division of the range of temperature between boiler and condenser is concerned.*

Third, Temperature of Interior Surface during Admission.—The outdoor stroke was performed at less than 100 ft. of piston speed. During this comparatively slow movement, the steam on both sides of the piston was at about 6 lbs. absolute pressure or 170° Fahr. in temperature, while the steam in the jackets was at 100° *greater* temperature. Under such conditions, it is not difficult to conceive that all moisture in the steam formed during expansion would be entirely driven off the interior surfaces, and the latter made to assume the temperature of the jacket steam, except an infinitely thin layer of metal in direct contact with the steam of 6 lbs. pressure. Hence when, upon the completion of the indoor stroke, the piston remained at rest for a time more than equal to the time of the whole outdoor stroke, with the clearance spaces full of steam of admission pressure, it is easy to imagine that the jacket, which had then a superior temperature of over 50°, could make the temperature of the interior surfaces, including the piston and cylinder head, quite equal to that corresponding to the pressure of admission if not in excess thereof. As a consequence of this, no steam could condense during the initial entry to the cylinder, and the superheating due the throttling could neutralize the slight condensing effect of the surfaces uncovered up to cut-off as the piston advanced. We conclude therefore that the Cornish pumping engine, besides possessing high piston speed, had all the advantages of a compound engine in the division of the range of temperatures to which the cylinder was exposed, and finally its periodic irregularity of motion, in conjunction with the wire drawing of the steam, afforded extraordinary facilities for the effectiveness of action of the jacket.* The combination of all of these features makes it entirely reasonable that the cylinder condensation in this type of engine should be less than in any modern engine, and entirely probable that the economy reported by WICKSTEED was the result of the entire absence of cylinder condensation, as his results indicate.

(TO BE CONTINUED.)

*Experiments with a 17 x 30 non-condensing engine at ⅛ ¼ and ⅓ cut-off, and at speeds varying from 8 to 90 revolutions per minute, has shown that there is a reduction of cylinder condensation equal to ½ lb. of steam per hour per H. P. for each revolution increase of speed per minute. See paper 349, Vol. X. Trans. Inst. Mech. Engrs.

†The accompanying indicator card Fig. 6, taken from a 17 x 30 non-jacketed engine at 77 revolutions, gave a water consumption of 54 lbs. per hour per H. P., which makes the cylinder condensation zero. Steam was throttled from 90 lbs. to the average admission pressure, 13 lbs. The range of temperature is only 23° Fahr. while the superheating due to withdrawing was 55 degrees. Less degrees of throttling gave amounts of cylinder condensation which were greater in proportion as the throttling was less. See paper quoted in preceding note.

‡A 7 x 14 engine was run at 160 revolutions with steam at 60 lbs. pressure cutting off at about one-third, and the condensation per stroke during admission found to be 0.31 lbs. The same range of temperature was produced by steam of 75 lbs. pressure throttled to atmospheric pressure, cutting off at the same point of stroke, and expanded by use of a condenser. The revolutions per minute were the same as in the first experiment. The condensation during admission was 0.15 lb. per stroke, or less than one-half that for the non-throttled steam. The superheating due to the throttling would be 60° Fahr. if the steam was perfectly dry, which in the case of the experiment was the case within 1 per cent.

§I am indebted for these figures, as well as for much information and the use of rare literature on the subject to a veteran engineering friend, formerly a close observer of the operation of Cornish engines. The distribution of time we determined by observation with a "split-second stop watch."

*It is worthy of note that in the Boulton & Watt pumping engines, in which steam of about 18 lbs. pressure was used without expansion, the economy as found by WICKSTEED was 34 lbs of steam per hour per H.P., a result consistent only with the absence of cylinder condensation. As such a result must, as shown above, be principally due to the jacket, it should be noted that this fact makes it quite consistent that WATT should have looked upon the steam jacket as conducive to considerable extra economy, and yet the use of a jacket be valueless on modern engines, where double uniform action and absence of wire-drawing during admission do not afford the facilities for its action present in Cornish pumping engines.

The Toronto Esplanade Question.

A very lively and aggressive movement, looking toward the execution of a great and somewhat novel public improvement, has been for some time in progress in the city of Toronto, Ont., and has now reached a stage of progress which seems to make it proper that we should fully describe it, as the case is one of great engineering interest, not for itself alone, but as a type of a large and increasing class of terminal problems which demand solution, arising from the rapid and simultaneous growth of cities and of railway traffic. The same problems in substance, therefore, are certain to arise again and again, as is now the case in all parts of this continent.

The city of Toronto, we may premise, is easily the most thriving and progressive city in Canada and has recently enjoyed a remarkably rapid growth. After comparatively slow increase from 45,000 in 1861 to 56,000 in 1871 and 86,000 in 1881, it jumped to 168,000 in 1888, and by 1890 91 seems quite certain to reach 200,000 or more. Its railway traffic, of course, has grown even more rapidly. Until lately this was practically confined to the Grand Trunk system, which absorbed four or five local lines, and to two or three still independent local lines which on the advent of the Canadian Pacific Railway were absorbed by that line. The natural effect of these conditions was to give the Grand Trunk almost a surplusage of terminal area, but yet an ill-arranged yard made up by successive accretions. Moreover, the Grand Trunk main tracks were naturally carried through the turn on a level along the water front.

This water front is strictly limited at Toronto (which has the only good natural harbor on the lakes) to the two mile stretch shown on the two maps, Figs. 1 and 2, herewith. The harbor is formed by a large sand island opposite the city, much used as a pleasure resort, and boating and yachting is naturally much favored by the large expanse of still water thus formed.

When the Canadian Pacific system, which now radiates in all directions from Toronto, came to seek terminal facilities at that port, they found the Grand Trunk already occuping all the double-hatched areas in Fig. 1, or nearly half the whole water front of the city; and also with a tight grip on Esplanade St., which it occupied with four tracks on the level along the whole length of the water front. Two of these tracks, by an almost ridiculous survival of village conditions, were used simply for standing cars on for loading and unloading, so that the whole street—naturally an important water front business street—became merely a long-drawn-out and dirty freight-yard.

These conditions depreciated the market value of the whole water front, and made it natural and comparatively easy for the C. P. R. to solve their terminal problem by buying up in the open market a sufficient area of the remaining water front from owners in fee or leasehold (the fee of the water-front is largely in the city); and this they did without opposition and at large expense, substantially as shown on our first map; when at last, in the eleventh hour only, the citizens of Toronto woke up to the fact that the whole water front of their city was in rapid progress of conversion into a railway yard; the part acquired by the C. P. R., as shown in Fig. 1, being the most used part of the remaining water front. In fact, a formal tripartite agreement had been drawn up between city officials and the two railways, legalizing and perpetuating the conditions of Fig. 1, and containing, it should be added, some liberal provisions by the C. P. R. and (less notable) G. T. R. to minimize the evils of such a situation by overhead bridges and otherwise; and only a disagreement about some really minor details awoke the city to a realization of how essentially inadmissible were the whole conditions. This very late awakening, in its turn, has naturally had a somewhat irritating effect on the railways, who say with great truth that if the city was not satisfied with what was proposed they should have been informed a year or two earlier, before such large expense of time, labor, and money had been incurred. Unfortunately, municipalities are apt to be slow in such matters, and yet cannot be expected to abandon reasonable, indeed necessary, demands because too tardily thought of. Now, at any rate, the city is practically united, we believe (the fact is denied, and not yet proven), in demanding something different and better, and stands ready to bear its fair share of the burden, if it is once clear what its fair share is.

The Board of Trade and the City Council took almost simultaneous action on the matter. The Board of Trade appointed a Railway Committee, of which Mr. D. R. WILKIE was chairman, and this committee engaged Mr. A. M. WELLINGTON, of New York, to examine into and report on the question, which he did on Aug. 16, 1889, proposing the readjustment of water front and terminal facilities outlined in Fig. 2. The Esplanade Committee of the City Council appointed Col. C. S. GZOWSKIE, of Toronto, and Mr. WALTER SHANLY, of Montreal, to report on the same question, in conjunction with Messrs. GRANVILLE C. CUNNINGHAM, Assistant City Engineer, and V. SANKEY, City Surveyor, which they did on Sept. 17, 1889, entering much more fully into local details, minutiæ of cost, etc., than the first report. In the mean time a Citizens' Association had been formed, and Messrs. J. H. ARMSTRONG, C. E., and JOHN GALT, C. E., with Mr. HUGH BLAIN, Chairman, submitted to them still a third report on the same matters, Oct. 30, 1889. Mr. ALAN MACDOUGALL, C. E., also acted as consulting engineer for the Citizens' Association.

The two last-named reports differed only in detail from each other, and from the first-named, but some of these details were important (a summary of them will be given later) and several conferences of engineers were held which resulted practically in a joint report. This was done under the auspices of a large joint committee of the City Council

Board of Trade, Citizens' Association, Harbor Commission, etc., a sub-committee under Mr. EDWARD GURNEY, Chairman, having immediate charge of details. This committee has now (Dec. 24, 1889), after receiving the engineers' reports, recommended a single plan, taking what it approved from each report, and differing from that shown in Fig. 2 only in the details noted briefly below it, and hereafter more fully.

Mr. WELLINGTON's report was in substance as follows, omitting details of merely local interest, and those relating to details of cost:

To the Chairman and Members of the Railway Committee of the Board of Trade of the City of Toronto:

GENTLEMEN,—Having been commissioned by you to examine the existing and proposed status of the railway facilities along the water front of the city of Toronto with the view of seeing what arrangement would be most in keeping with the interests and wishes of the citizens and of the great railway companies concerned, and having fulfilled your instructions in that respect by a careful study of the situation, I now beg leave to submit the following report:

The difficulties which are now felt in Toronto are in their substance common to it and to nearly every other large city on the continent, all arising from the general fact that the railways and the cities have grown up together very rapidly from small beginnings, when the magnitude to which the traffic of each would grow was little appreciated and when, even if it had been appreciated, capital was too scarce and costly to admit of adequate provisions to avoid such future difficulties.

To have exacted such provisions would have prevented the construction of most of the early railways altogether, and it was therefore in the interests of the cities themselves that a cheaper kind of construction was permitted. Under modern conditions very great annoyances are already resulting from such early practice in Toronto and many other cities; but great as the evils now are, it is important to remember in any study of such problems that they still tend to become rapidly greater, owing to the simultaneous growth of the cities and railway traffic, which for many years to come is certain to go on in almost geometric ratio. Any plan, therefore, which will not be adequate for at least double the present population and present railway traffic is to that extent imperfect.

The situation in Toronto is in two respects more favorable than in most other cities. In the first place, there are but two corporations to deal with and to satisfy in regard to any proposed plans, the Grand Trunk Railway and the Canadian Pacific Railway, these two great companies having absorbed the six other independent lines which formerly entered the city. But for this fortunate fact, it would probably be hopeless to attempt to reconcile conflicting interests. I do not understand either of the two great resulting corporations to be in a position to incur any large present expense for Toronto betterments, nor have I to propose that either of them shall incur any such expense, but it is far easier to provide for satisfying all their reasonable demands than if there were eight or nine corporations, as there were and are in the city of Buffalo, for example.

The second favorable feature of the situation in Toronto is that the difficulties are all confined to a narrow strip along the water front. Owing to the topography of the city, and to the enlightened policy of providing over or under crossings for all important streets, which has been entered upon earlier in Toronto than in most similar cities, it is not likely that any further local difficulties of the kind above referred to will arise for a long time to come, if the water front problem be at once adequately settled.

On the other hand, the Toronto situation is unusually unfavorable in this: that the entire available water front of the city is now occupied by six railway tracks, over which nearly all the railway traffic to and through the city now passes. The entire length of this available water front is limited, being but a few feet over two miles, and there are but few points on it to which access can be had without crossing on a level these six tracks. The resulting disadvantages were in the beginning small, there were few trains and few people wishing access to the water front. They are already great. They must in a few years more become much greater than they are now. About half of this water front has been for years under railway control and not generally accessible. This we may throw out of account. In my judgment any plan for adjusting the situation, to be regarded as entirely acceptable, should provide for permanently relieving the remaining mile of water front, from York St. to Berkeley St., from all obstruction by tracks, leaving access to it perfectly free. It is a scant water front at best for a city of half a million of people such as Toronto bids fair to become. It can be and it should be free from all obstruction by railway tracks.

The intolerable nature of the evils which may flow from a situation like the present one may be better comprehended by fancying a six track belt railway on a level, extending all around the water front of New York.

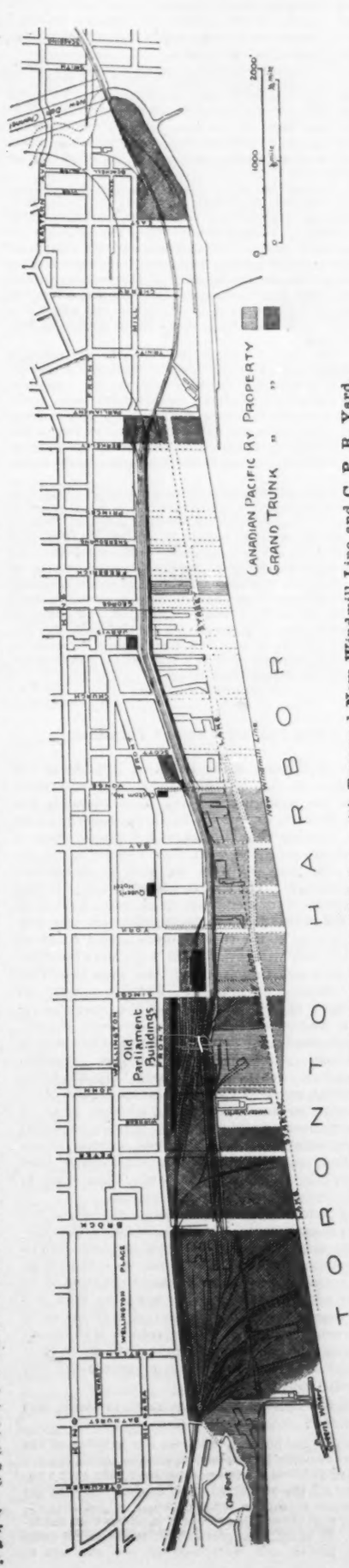


Fig. 1. Toronto Water Front as now Existing, with Proposed New Windmill Line and C. P. R. Yard.

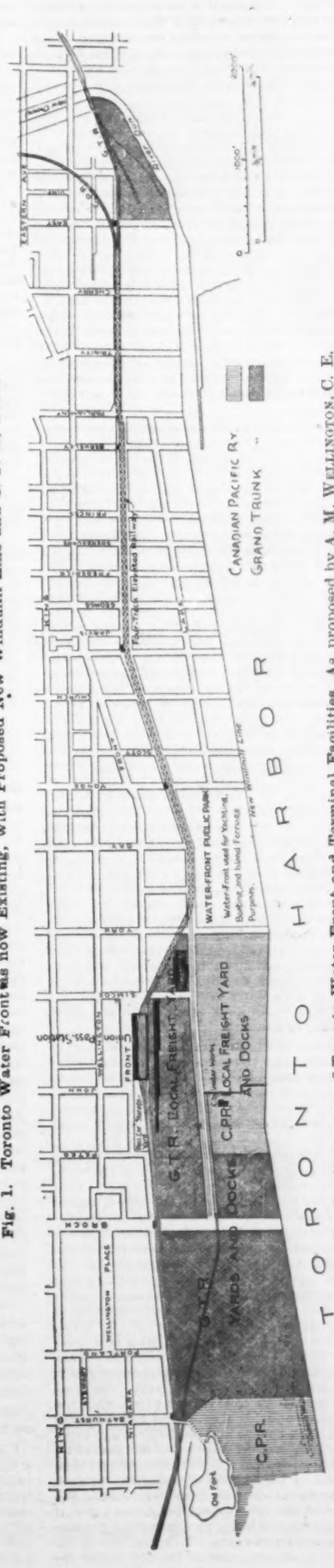


Fig. 2. Readjustment of Toronto Water-Front and Terminal Facilities. As proposed by A. M. WELLINGTON, C. E.

THE TORONTO, ONT., ESPLANADE AND TERMINAL QUESTION.

[The changes from the arrangements shown in Fig. 2, which have been recommended by the Esplanade Committee after the various conferences noted, are as follows: 1. The four-track viaduct is converted into a two-track capable of enlargement into four-track. 2. The public reservation extends from York to Scott, instead of from York to Yonge, and is not in terms devoted to use as a park. 3. The Grand Trunk yard is curtailed by throwing the new Union Station southerly on to it. 4. The Canadian Pacific Railway yard is curtailed by stopping it at the City Water-Works lot on the west.]

The port would be destroyed. It is not likely that Toronto will ever have the present population of New York, and still less likely that there ever will be as many people and teams seeking access to each mile of water front; but the population of Toronto per mile of water front is already larger than New York's, and a much less active use of it would cause such an obstruction to be regarded as an intolerable evil.

Two methods of remedying this evil exist,—by building overhead roadway bridges across the tracks, or by lifting the tracks bodily above the street level on an elevated structure. The overhead bridges are far better than nothing, but under the conditions existing in Toronto their use is open to several very serious objections. It seems unnecessary to consider these objections in detail, however, as I judge that by the plans subjoined the necessities of the existing situation, and the reasonable wishes of all three of the parties interested, viz., the Grand Trunk Railway, the Canadian Pacific Railway, and the city of Toronto, will be met more completely than by any other plan which has been submitted or has occurred to me, and it provides for elevating the tracks above the streets along the stated mile of water front. I have constantly borne in mind that any plan, to have reasonable chance of adoption, must do equal justice to all of these three great interests, and must, if possible, be more favorable to each than any other available one would be.

The plan which I have to propose as meeting these conditions is in brief this: That a new Union Station shall be constructed on the south half of the Old Parliament Building Square bowing Front St. out around it to the north. The grade of the tracks in this building to be about 15 ft. above the tracks in the present Union Station. The building to be approached from the west by a four-track road on the solid, starting from about Bathurst St. and rising by a very gentle incline along the south slope of Front St. A four-track viaduct [since cut down to two-track for the present,—Ed.] to start from the station eastwardly and run through the center of Esplanade and Mill Sts., in a nearly straight line to a point somewhat west of the Don River crossing, where it will fork, one double-track branch being for the Canadian Pacific and one for the Grand Trunk. The elevated tracks to pass over the upper deck of the Don bridge at about the level of the upper chords of the present bridge. Thence the Grand Trunk tracks to be carried nearly level on an earth fill until they reach the grade of the present tracks [which they do in about half a mile.—Ed.] The large area between York St. on the east and Peter St. on the west, and between Front St. on the north and the new "Windmill" or Bulkhead line on the south, to be given up wholly to local freight use, the Grand Trunk retaining the north half of this area, which it now uses, and the Canadian Pacific Railway having the south half. All this area, as also nearly the equal area west of it, between Bathurst and Peter Sts. now owned and used by the Grand Trunk exclusively, to be free from all interference by city streets and traffic, beyond the slight amount which now exists. The city to assume from the Canadian Pacific Railway all the land and right of way which it has acquired along the Esplanade from York to Parliament Sts., and credit that company with it, as below suggested, converting the block between York and Yonge Sts. into a water side park, with piers and boat houses for the yacht clubs, island ferries, and other pleasure boating interests.

The scheme thus hastily outlined is considered more in detail below, and must be so considered to be fully understood, but its main scope and purpose will be understood from the above, and from a study of the accompanying map. The total cost of the work thus outlined should not exceed $2,654,300, as will appear in more detail below.

As it would be useless to suggest the expenditure of so large a sum of money without seeing how it was to be obtained, I have further to suggest that the entire work should be carried out at the cost of the city through a non-political commission appointed for that special purpose, and that running rights over it be granted in perpetuity to the railways concerned at a fixed annual rental, which rental should be such as to return to the city say 2½ to 3 per cent, of the cost, the city to retain power to grant similar running rights to any and all other companies which may apply for it after securing access to the viaduct terminals at Bathurst St. or the Don River, or both, but the rental received from such new companies to go toward the reduction of other rentals, so that in no case should the city exact a larger total rental than 2½ per cent. on the cost of the work. The companies using the station and viaduct to maintain the works in addition to paying rental. For reasons below more fully outlined, I judge it to be equitable and expedient that the companies using the works should contribute to the maintenance and rental charges in equal fractions, regardless of the number of trains run by each leaving each to run as many or as few as it pleases. The companies would naturally expect and demand that, if the works were executed under the control of a commission, the maximum rental charge which they were to pay should be fixed in advance, leaving the city to bear the whole burden of any unforeseen excess of cost, but giving them the benefit of any reduction in cost below the estimate.

The reasons which seem to make this method of construction expedient are these:

1. The two great companies which now furnish Toronto with such excellent railway facilities are neither of them in a financial position to undertake such a costly work, if I correctly understand their financial status.

2. They have not the same necessity for doing so. They can both of them get along fairly well under their existing or proposed arrangements. It is the City of Toronto which will be the greatest sufferer.

3. The city can raise the money easily at 3½ to 3¾ per cent. The companies would in one way or another have to pay nearly double that, even if it be practically possible for them to raise it at all. Under the suggested arrangement the improvements will cost the companies $33,000 to $36,000 per year each, gross, from which is to be deducted interest on the value of the property turned over. Were they to construct the work themselves the cost might be $80,000 ea'h. They can well afford the smaller sum, while they might easily hesitate at the larger sum.

4. The City of Toronto owes more to the railways than the railways owe to Toronto. However it may be with a property like the New York Central, which has been enormously profitable to its owners, there would be an injustice in forcing comparatively poor corporations, which have yet served the public as well as the New York Central, into expenses demanded much less by the growth of their own traffic than by the growth of the city.

5. If the railways contributed a part or all of the cost of the structure, they might with reason demand that it should be retained forever for their sole use. This is not for the interest of the city, nor should it be permitted under any circumstances. While there seems no immediate probability of any third company coming to the city, nor any need therefor, the city should carefully guard the right of any new company to obtain running rights to the union passenger station, nor can either of the present corporations serving the city reasonably object to this. It will still be difficult enough for any such company to place itself in a position to complete for Toronto business on equal terms.

(TO BE CONTINUED.)

The Brooklyn Bridge Terminals.

The application of the Board of Trustees of the Brooklyn Bridge for leave to condemn additional lands for enlarging the New York terminus has been granted, as was all but inevitable from the first, it being plainly without the proper scope of the courts of law to determine whether or not the measures proposed were the best for the end, or eevn effective. The land is wanted to carry out the double-platform guantleted-track plan, known as the Barnes-Martin, adopted by the trustees last year, which at the time it was claimed could be carried out without buyiug any more land, although it was sufficiently evident even then that this was not at all the case. The plausible ground on which the condemnation of the land was opposed was that "no necessity had been shown" since it was denied that the plan was either safe or workable. A good deal of testimony on this point, pro and con, was taken, bnt Judge O'BRIEN, of the New York Supreme Court, holds this ground of objection to be untenable legally, whether sound or not practically, in a very sound opinion reprinted below, which will have a certain interest to our readers from its bearing on a considerable class of similar questions which arise from time to time.

The bridge officials have now, therefore, full power to carry these plans into operation if so disposed. It remains to be seen what the result will be The plans as then proposed, and in substance as now proposed, were described and illustrated by us in our issue of April 28, 1888, when the plan was first adopted. That their nature may be better understood by the large class of readers who cannot be expected to carry such details very long in their memory, we shall next week reproduce this cut from our issue referred to.

Judge O'BRIEN'S opinion, referred to above, was as follows:

I fail to see how any question can arise upon the testimony taken in this case as to the necessity of the lands in question for the purposes set forth in the petition. All the witnesses examined on behalf of the petitioner, as well as those called in opposition, admitted that the existing terminal facilities were inadequate. It is ma'e to appear that the terminal platforms now in use were built in 1882 and 1883 to accommodate about 7,200 passengers an hour, and were then thought to be sufficient, being accommodations 40 per cent. greater than had prior to that time been carried by the Fulton Ferry. That this original view was correct is evidenced by the fact that according to the table furnished it is shown that during the first years—1883 and 1884—the bridge carried 8,000,000, the terminal facilities being entirely adequate. The traffic, however, has so increased that there were carried last year on the railroad over 32,000,000 passengers. This increased traffic, notably during the evening hours, has rendered the New York terminus so overcrowded that there is an ever-present danger to life and limb. Fourteen thousand passengers cross within one hour every evening to Brooklyn, and according to the testimony of one of the witnesses, the crowd fills not only the platforms, but the approaches and stairways, and a moment's delay in the trains, or a slight increase in travel from rain or an accident, will accumulate a crowd which will reach beyond the ticket boxes and stop the sale of tickets. To secure facilities for running the railroad, to accommodate the ever-increasing traffic without imperilling life, more tracks and platforms, together with the necessary additional approaches and stairways to give access and egress, are required. This additional space or land so required is here sought to be condemned. It is strenuously contended that the use to be made of the additional land sought to be acquired, as shown by the plan, is inconclusive, by failing to prove that, if adopted and carried into effect, it will fail to secure such needed additional facilities or conduce to a better operation of the railroad or the public weal. The answer to this line of reasoning, however, is apparent, if the necessity for condemning the land for public use is shown. It hardly comes within the scope of a judicial inquiry to examine and determine as to the relative merits of rival plans, and thus take away discretion in this respect vested in the trustees by statute. In Curtis vs. Leavitt, 15 N. Y., p. 64, where this question as to necessity in connection with the power vested in trustees of determining as to the different modes of exercising the same is discussed, the following language is used:

It is truly said that corporations can only exercise such incidental powers as are necessary to carry into effect the express objects of their charters. But necessity is a word of flexible meaning. There may be an absolute necessity, a great necessity, and a small necessity; and between these degrees there may be many others depending on the ever-varying exigencies of human affairs. It is plain that corporations, in executing their express powers, are not confined to means of such indispensable necessity that without them there could be no execution at all. The contrary doctrine would lead at once to a very great absurdity; for if there are several modes of accomplishing the end, neither one is indispensable, and each would exclude all the others. And thus, by inevitable logic, an express grant of power would lie forever dormant, because there are more modes than one of carrying it into execution.

It is almost as difficult to say that the incidental power depends for its existence on the degree of necessity which connects it with the power in chief. Such a doctrine would impose upon courts a never-ending difficulty, for the inquiry would always be whether the chosen instrumentality is the very best that could be selected; and if not the very best, however minute the difference may be, then the inevitable decision must follow that the choice was fatally bad, although strictly adapted to the end in view and made in the utmost good faith. These demonstrations, for such they appear to me, would seem to leave but one other conclusion, which is that corporations, along with their specific powers, take all the reasonable means of execution, all that are convenient and adapted to the end in view, although not the very best by many degrees of comparison And this is a doctrine which must necessarily result in the liberty of choice among those means. The choice may be wise or unwise. If made in the exercise of an intelligent good faith, the wisdom of the selectmen may be called in question, but the power to make it cannot be.

In the matter of the Union Elevated Railroad Company, 113 N. Y., p. 275, Judge GRAY wrote as follows:

If the charter seems to authorize the proposed taking, and the action of the directors seems to be free from the influence of unworthy or dishonest motives, I do not see why the courts should interfere with the exercise of their discretion. Granted the power, and no suspicions of the honesty of corporate intentions being maintainable upon the proofs, the court cannot interfere with the exercise of the power. The only limit to its exercise would seem to be the reasonable necessity of the corporation in the discharge of its duty to the public.

While, therefore, the question of a necessity is one which may be inquired into, except in cases where the land sought to be taken has been designated by legislative act, and while the determination of the Board of Directors or Trustees is not conclusive upon the question, yet when the necessity has been shown by competent proof, and no suspicions of the honesty of corporate intentions or bad faith is alleged, the court will not interfere with the exercise of a reasonable discretion.

LOCOMOTIVE BUILDING IN 1889, according to statistics collected by the *Railroad Gazette*, was less active than in 1888. In the past year it reported 1,860 engines built by 16 firms. In 1888 there were 2,180 locomotives built by 17 firms.

Head-Gates and Boom of Main Canal, Dolores, Col.

(With Inset.

This week's inset illustrates the full detail of the head gate and boom of the main canal of the Colorado Water Supply Company, as kindly furnished by the Chief Engineer, Mr. W. H. WELLS, C. E.

The inset, being reproduced from the working drawings, sufficiently explains itself. The bill of material on the original plans may be summarized as follows:

Head Gates.—Timber, 7,835 ft. B. M.; iron bolts and washers, 71 lbs.; 20d nails, 73.4 lbs.; 33 railroad rails, 1¾ ins. high and 30 ft. long, and all gate gearing to be furnished by the company.

Six Gates.—Timber, 641 ft. B. M; bolts, washers, and nails, 151.2 lbs.; all gearing, railroad iron, and spikes to be furnished by the company.

Four Wing Walls.—Timber, 6,961 ft. B. M.; bolts, washers, and nails, 95 lbs.

One Wing Extension Wall.—Timber, 1,740 ft. B.M.; bolts, washers, and nails, 24 lbs.

The total of lumber used is 17,177 ft. B. M., and the total of wrought iron, exclusive of gearing and rails and spikes above referred to, is 414.6 lbs.

The head-gates of the Colorado Water Supply Company are situated near the town of Dolores, on the Dolores River, Montezuma County, Colorado. The Montezuma Valley Water Supply Company, "fell by the wayside" in the construction of their works, and went into the hands of a receiver, with but little canal work completed, and less than two-thirds of a 5,400 ft. tunnel finished. The receiver constructed the tunnel and partially finished several laterals, when the old rights were brought up by Portland, Me., parties, under the style of "The Colorado Water Supply Company."

The old company had at an enormous expense put in a boom near the north portal of the tunnel, and this was used as a head-gate during the season of 1889; at the time the boom was put in place, great and apparently insurmountable obstacles were encountered, and the floor of boom was left 2 ft. above the bed of the river. In August and September, as well as the latter part of July, it became impossible to persuade water (which was then low in the river) over the boom, and a wing dam had to be thrown across the river to carry water enough into the tunnel and main canal to supply the demands for the remainder of the same.

Such a state of matters not being admissible, the coming season plans for new head-gates, to be placed 2.7 ft, below the normal bed of the river (at the location of head-gates) were prepared and work began early in October. The situation of the gate was not all that could be desired, but it was the only point for a gate to connect with the tunnel, which could not well be abandoned.

The ground consists of some 4 ft. depth of slimy, treacherous mud, full of roots, willows, and débris of all kinds; this was succeeded by 1½ ft. of quicksand, after which a good foundation of gravel and boulders was reached. The main expense attached to the head-gate was setting and digging out material below the river bed.

A row of sheet piling was driven on the east, or river side, and a channel 25 ft. broad on the bottom and 6 ft. deep was first excavated to the tunnel, in order to assist in disposing of the water and act as main canal when next season began.

After getting below water level, in the river, it became almost impossible by working two pumps, and both night and day, to keep the excavation clear of water. To add to his trouble, the frosty nights came on, rendering another difficulty in the way of keeping laborers in the pit working up to their knees in ice-cold water.

After being, so to speak, submerged for three weeks the new sills and floor beams were set to grade; often it was comparatively a small matter to finish the structure and back fill. It may as well be added that before back filling all the bottoms and wings were tamped and packed with horse manure; this material being found by the engineer unequalled for preventing leakage and stopping leaks in dams since the gate was completed. No difficulty of any kind has been discovered in operating, and now, in a *low* stage of water, the gauge on the river side of gate shows 5 ft. of water, promising good returns for the trouble this fall, when the next irrigating season begins.

On December 9, a rock dam on south portal of the tunnel was completed, which diverts water into the "narraguinip" and "East Laterals," a sketch of which it is hoped will be shortly given in this journal.

The Sault Ste. Marie Canal.

Gen. O. M. POE, United States Engineers, has just returned from an official inspection of work on the Sault Canal. He reports Collins & Farwell, the contractors, as having thus far performed one sixth of the work, which is not as much as Gen. POE expected. They have only about 150 men employed. The canal is now closed for the season, and the following tabulation shows the business of the last two years:

COMPARATIVE STATEMENT OF THE AMOUNT AND VALUE OF COMMERCE THROUGH THE ST. MARY'S FALLS CANAL, MICHIGAN, FOR THE CALENDAR YEARS 1888 AND 1889:

Items.	Quantity.		Increase.		Decrease.		Price per unit.	Total valuation.	
	1888.	1889.	Amo'nt	%	Amo'nt	%		1888.	1889.
*Vessels, number	7,803	9,579	1,776	23	.....	.....	.....	.....	.....
Lockages, number	3,845	4,684	839	22	.....	.....	.....	.....	.....
Tonnage, registered, net tons	5,130,759	7,221,935	2,091,276	41	.....	.....	.....	.....	.....
Tonnage, freight, net tons	6,411,423	7,516,022	1,104,599	17	.....	.....	.....	.....	.....
Passengers, number	25,558	25,712	154	01	.....	.....	.....	.....	.....
Coal, hard and soft, net tons	2,105,041	1,629,197	.....	.....	475,844	23	$ 3 50	$ 7,367,643 50	$ 5,702,189 50
Flour, barrels	2,190,726	2,228,707	37,982	02	.....	.....	5 00	10,953,625 00	11,143,535 00
Wheat, bushels	18,596,351	16,231,854	.....	.....	2,364,497	..	98	18,224,423 98	15,907,216 92
Grain (other than wheat)bush'ls	2,022,308	2,133,245	110,937	05	.....	.....	98	1,981,861 84	2,090,580 10
Manufactured iron, net tons	48,850	31,545	.....	.....	17,314	36	50 00	2,442,950 00	1,577,250 00
Pig iron, net tons	14,844	26,016	11,172	77	.....	.....	17 00	252,348 00	442,272 00
Salt, barrels	210,433	168,250	.....	.....	42,183	20	1 00	210,433 00	168,250 00
Copper, net tons	28,960	33,456	4,496	16	.....	.....	200 00	5,792,000 00	6,691,200 00
Iron ore, net tons	2,570,517	4,095,855	1,525,338	59	.....	.....	3 50	8,998,800 50	14,335,492 50
Lumber, Mft. B. M	240,372	315,654	75,182	31	.....	.....	18 00	3,326,986 00	5,679,972 00
Silver ore and bullion, net tons	3,385	5,947	2,564	76	.....	.....	153 79	520,579 15	914,589 13
Building stone, net tons	33,541	33,538	.....	..	3	00	10 00	335,410 00	335,380 00
†Unclassified freight, net tons	345,854	312,410	.....	.....	33,444	10	60 00	20,751,240 00	18,744,600 00
Totals	.....	.....	.....	.....	.....	.....	.....	$ 82,156,019 97	$ 83,732,527 15

*Steamers	6,501
Sails	2,635
Unregistered craft	444
Total	9,580

† Included in unclassified freight for 1889.

Wool, 2,946 tons and hides 304 tons.

Valuation based on estimates of 1885.

Valuation for 1885	$53,413,472.13
Valuation for 1886	69,080,071.95
Valuation for 1887	79,931,757.78
Valuation for 1888	82,156,019.97
Valuation for 1889	83,732,527.15

Canal was open to navigation during season of 1888, 212 days.

Canal was open to navigation during season of 1889, 234 days.

NATIONAL REGULATIONS FOR BRIDGES OVER THE MISSISSIPPI AND TRIBUTARIES.—Secretary PROCTOR has approved a bill which is judged likely to pass, under which bridges in the future must be built according to the following requirements: On the Missouri River, about the mouth of the Platte, all bridges to have a channel span not less than 300 ft. long and head room of 50 ft above high water; between the Platte and Kaw Rivers, all spans over waterway to exceed 300 ft., channel spans 400 ft. and head room of 50 ft. above high water; between the Kaw River and the mouth of the Missouri, all spans over waterway to be 400 ft, 50 ft. above high water; all bridges on the Missouri to be high bridges; on the Mississippi River above the mouth of the Missouri, and on the Illinois and Desplaines Rivers, all high bridges; spans over waterway to be not less than 350 ft., and 55 ft. above high-water mark; no part of the structure to be less than 10 ft. above high-water mark; all low bridges to have two or more draw openings of not less than 200 ft. channel way, and one fixed channel span of not less than 350 ft. (Some slight local modifications of these requirements are permitted on the Illinois and Desplaines Rivers.) Pile and pontoon bridges, similar to the one at Prairie du Chien, Wis., may also be built.

Between the mouth of the Missouri and St. Louis, bridges shall be 400 ft. spans over the waterways, 500 ft. channel spans, and 55 ft. above high water. At St. Louis, north of the Eads Bridge, channel spans of 500 ft., 55 ft. high. Between the Eads Bridge and the mouth of the Ohio, the spans over waterway to be 500 ft., channel spans 650 ft., all 65 ft. above high water. Between the Ohio River and Natchez, spans over waterway must be 600 ft., length of channel span to be prescribed by the Secretary of War, all 70 ft. above high water.

These are pretty stiff requirements, but they can be met, and doubtless hereafter will have to be met.

Mr. RICHARD H. BUEL, the well known mechanical engineer, has disappeared. He was last seen the Friday before Christmas, when he said he was going to Boston and would be home on Christmas. He did not return, however, and detectives have been unable to find any trace of him in New York or Boston. He was in good health, had good habits and a good business, and so far as is known, he had no unpleasant entanglements of any kind, nor did he carry large sums of money with him.

Mr. BUEL is about 45 years old and was many years ago an instructor in the Naval Academy at Annapolis and later at the Stevens Institute, in Hoboken. He is unmarried.

Foundations of the Northeast and Southwest Quays of the Outer Harbor of Calais, France

The following is a translation in part of a report on the Harbor of Calais recently made by the Chief Engineer in charge, M. BETILLART, and kindly forwarded to this journal by Capt. F. A. MAHAN, U. S. Engineers.

While work was going on, the excavation for the outer harbor was separated from the channel by only a mere sand coffer-dam, some parts of which were on old structures, so that no absolute reliance could be placed on either its strength or tightness; it was therefore considered prudent not to pump the water out below the limit fixed for the earth works to be carried on out of water.

The foundations had therefore to be sunk for both quays 5 metres (16.40 ft.) below the bottom of the excavation. The general width of these foundations is 7 metres (23 feet). To dig in fine, easily moved sand, trenches 23 ft. wide and 16.40 ft. deep, and found the quay walls, it was necessary to make very costly timber inclosures, excavate the sand from the interior, and lay under water a high mass of concrete, an operation which could only be carried on under defective conditions. It would certainly have been better to resort to some of the methods of laying foundations by means of compressed air These methods are also expensive, but more sure. After a few trials, which gave excellent results, the engineers proposed to apply to the sinking of masonry wells with rectangular bases as great even as 23 ft. square by 16.40 ft. high, the system, pure and simple, devised at Calais for driving wooden piles.

The system as originally proposed was rigorously carried out for the entire foundation of the north east quay. The continuous wall of this quay has a normal thickness of 23 ft. The foundation was formed of wells of which the outside horizontal section was rectangular, 6.50 metres (21.32 ft.) long, parallel to the face of the wall, and 7 metres (23 ft.) perpendicular thereto. The horizontal section of the interior is octagonal, or better a rectangle having its sides parallel with the outside, and the right

angles cut off, so as to strengthen the masonry at the four corners.

The outside faces of the well are vertical. The faces of the inside are built up vertically to a height of .50 metres (1.64 ft.) from the base, the thickness of the walls being 1 meter (3.28 ft.). From this point the masonry overhangs toward the center, for a height of 2.10 metres (6.89 ft.) so as to increase the thickness of the sides to 1.75 metres (5.74 ft.), this thickness being then maintained to the top. The total height of each well is from 4.50 to 5.00 metres (14.76 to 16.40 ft.).

The blocks were built on the ground at the bottom of the excavations without the interposition of any plank or timber frame. The base, for a height of 0.50 metres (1.64 ft.), was made of a mass of hydraulic cement concrete laid inside of a mold which could be taken apart. So soon as the concrete was sufficiently hard, the rest of the well was built of rubble masonry with hydraulic cement mortar. As a rule, the sinking of the blocks was not begun until ten days or a fortnight after they were finished. This operation was performed by stirring up the sand under the block by means of a strong and continuous current of water and then throwing the mixture of sand and water outside of the well. This current was obtained by means of force pumps which took the water from the bottom of the excavations, and a centrifugal pump which returned to the excavation the sand and the water sent in by the force pumps.

The centrifugal pump was driven by a 10 H. P. portable engine. The suction pipe, suspended from a light scaffold, descended vertically in the middle of the well, the mouth being a little below the base of the well. The force pumps used were four small direct-acting steam pumps, discharging about 150 gallons per minute. Each pump supplied three nozzles at the end of iron spiral india rubber hose, passing over sheaves borne by a light temporary scaffold on top of the well. The steam was supplied by two vertical boilers.

All this plant was set on four small cars running on a track laid on the bed of the excavation parallel with the face of the wall. Of the twelve nozzles in use, eight followed down the interior walls of the well at the middle of each side of the octagon, the remaining four being arranged around the suction pipe of the pump; three of them opening out around the suction head kept the sand well stirred up, increasing the discharge and reducing the chances of choking. The twelfth nozzle was permanently attached to the suction pipe, and discharged inside the latter just above the foot valve. This arrangement devised by Conductor DEANNOY, in charge of carrying on the work, was an almost complete preventive of the choking which caused at first great loss of time.

The streams from the nozzle all working together stirred the sand up in the water and the sandy mixture was thrown out by the centrifugal pump. Care was taken to so regulate the amount of water thrown out as to keep it about equal to the amount pumped in and to keep the level of the water in the well very slightly below the normal level of the water in the ground. In this way there was no danger of the sand outside caving into the well, and but very little more than the volume of the well was pumped out.

Two spirit levels set at right angles gave the means of closely watching the regularity of the sinking. There was almost no trouble in keeping the bubbles within their boundaries by merely lowering or raising the nozzles so as to make them cut the sand to a greater or less extent.

When a well had reached bottom after going down about 4 or 5 metres (13, 12 to 16.40 ft.) according to the level of the bottom of the excavation at the point where it was sunk, the sand was allowed to settle around it: then it was filled up for a height of 2 to 2.50 metres (6.56 to 8.10 ft.) with concrete, laid under water, made of pebbles, Tournai lime, trass and sand.

When this layer of concrete had hardened, it formed, by reason of the shape of the bottom of the well, a perfectly tight plug, which resisted the under pressure of the water. The inside of the well was then pumped out, and the filling was continued with Portland cement concrete to the level at which it was possible to complete the filling with masonry. Each well thus formed a perfectly solid foundation block.

The following method was followed for making the foundations of the quay: A general plan was prepared showing the dimensions and positions of each well, maintaining between two adjoining wells a space of 0.40 metres (1.31 ft.), which was to be filled afterwards. The lines were laid out and the odd-numbered wells were built and sunk, and after them the even-numbered. Experience had shown that two wells, separated by the space required for a third, could be put down just as though each one stood alone. On the other hand, when the sinking of the even-numbered wells was carried on, it was found that influences of the two adjacent wells was neutralized, so that the putting down went on very regularly although rather more slowly.

No filling was put into a well until its neighbors had been sunk, so as to avoid any trouble which might arise from the sand being possibly drawn from under the foundation. When a whole row of consecutive wells had been put down and filled, the spaces between them were filled up. Vertical grooves had been made in the adjacent faces so as to facilitate fastening the blocks together, which operation was carried on as follows:

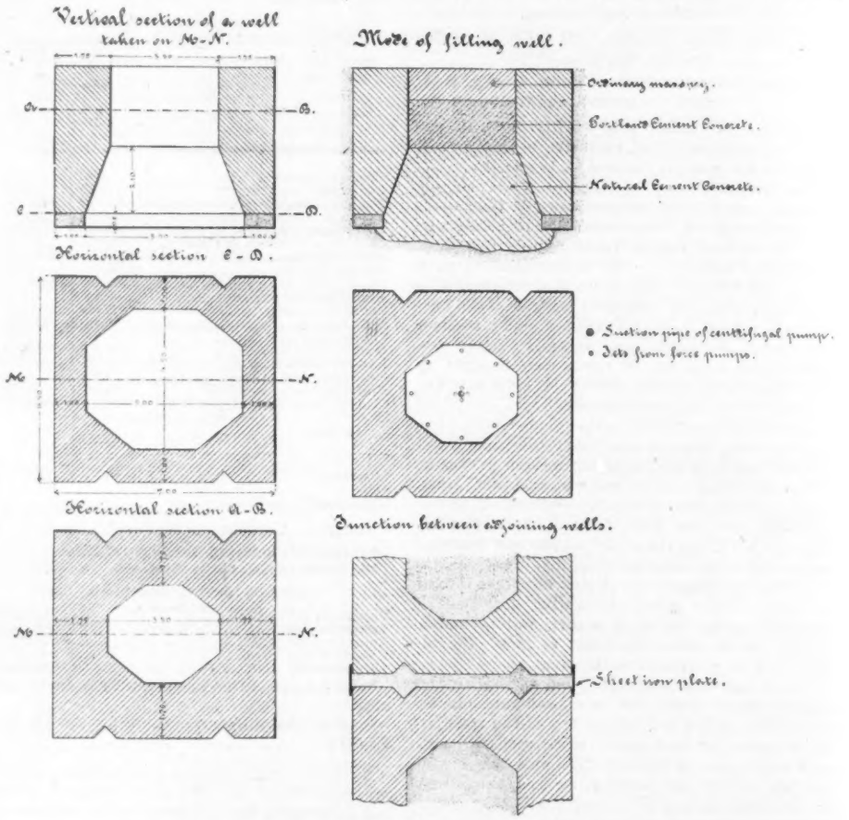
Over the outer and inner faces of two adjacent wells was put down a piece of sheet-iron, by means of a water-jet, until it reached the bottom of the wells. These sheets of iron formed an inclosure where the sand was stirred up and pumped out as already described. The space was filled up with concrete of hydraulic lime and trass. On the blocks thus joined was built the upper part of the wall, formed of a perfectly homogeneous masonry mass of rubble laid in Portland cement mortar.

The construction of the concrete base of the wells, sinking these wells, and removing the sand were carried on by day's labor; the contract work included the construction of the masonry, making and using the concrete for filling and connecting the blocks.

On account of the ease with which the foundations of the northeast quay were put in, the dimensions of the wells for the foundation of the southwest quay were increased as well as the depth to which they were sunk. These wells, of which the outside section was 8 by 8 metres (26.24 by 26.24 ft.) and the height 8.75 metres (28.70 ft.), were built and sunk in two operations by the methods already described. The total weight of each was about 800 tons. They were sunk with the same strict exactness as that of the smaller wells of the northeast quay. But rather more difficulty was found in joining them to prevent the entrance of sand, which had a tendency to come in under the sheets of iron.

The length of time required to sink a well 6.50 by 7.00 metres to an average depth of about 4.50 metres varied from 10 to 35 h., with an average of 21 h. 45 min. for the odd-numbered wells; and from 15 h. 30 min. to 65 h., with an average of 23 h. 45 min., for the even-numbered wells. The volume displaced per hour was 6.35 cubic metres (8.30 cu. yds.) on an average per hour for both odd and even-numbered wells.

The length of time required to sink the wells 8 by 8 metres to a mean depth of about 8 metres varied from 33 to 92 h., with an average of 43 h. for odd-numbered ones; and from 22 to 119 h., with an average of 45 h. 35 min., for the even-numbered wells.



Foundations; Outer Harbor of Calais, France.

The volume removed per hour was 10.88 cubic metres (14.22 cu. yds.) as an average for both odd and even numbered wells.

The cost of sinking the wells was 99,000 francs ($19,800), including 27,500 francs ($5,500) for purchasing a double set of pumps and hose, forming the plant for two outfits. This cost corresponds to a total volume of material removed of 31,253 cubic metres (40,848 cu. yds.), which brings the net cost to about 3.17 francs for a cubic metre of sand removed and replaced with masonry. (3.17 francs per cubic metre equals $0.484 per cu. yd.) The cost of removing the sand from between the wells and replacing it with concrete was 16.24 francs per cubic metre, ($2.49 per cu. yd.)

THE WORLD'S EXPOSITION SITE, as finally chosen by the Site and Building Committee, comprises 393 acres of land, nearly all of which has been already secured. The total area of Morningside and Riverside Parks is 246 acres, so that the Committee has been obliged to arrange for 144 acres with private owners. While we greatly regret that an enlarged Governor's Island was not chosen for the site, as conspicuously the best of all, it cannot be denied that the site chosen is a good one, now that Central Park is left out of it.

A Wrought-Iron Turntable, Half-Through Type.

We illustrate herewith a turntable of somewhat novel style, made by Cofrode & Saylor of Philadelphia, Pa. The construction of the center is similar to that of the deck turntable, made by the same firm, illustrated and fully explained in our issue of Dec. 21. The pit required for the half-through table is much shallower than for the deck table, as may be seen by comparing the accompanying table with that given last week. There are few accidents more provoking than to have a roundhouse full of engines blocked up by the failure of the turntable, necessitating perhaps the cancelling of important trains. Iron turntables do not burn or rot out; and while they are not as cheap in first cost as a wooden turntable, they will generally be found much cheaper in the long run.

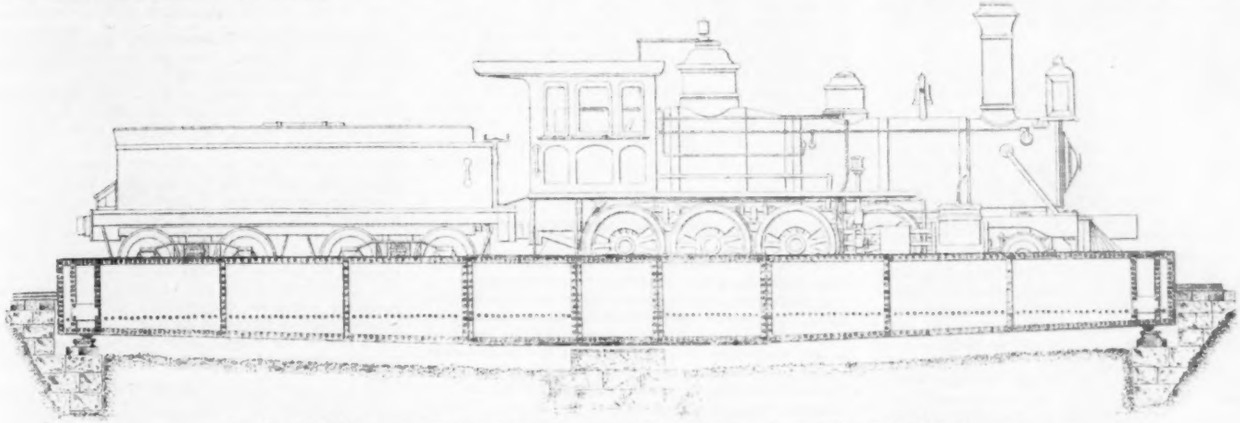
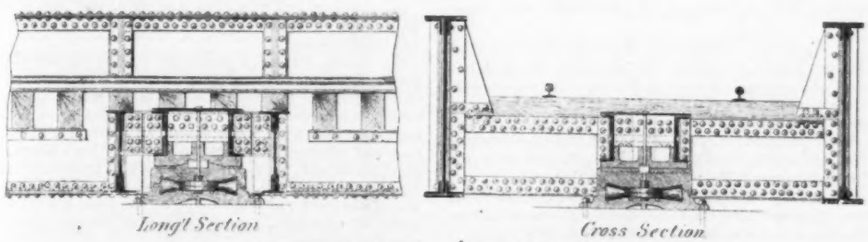


Fig. 1. Half-Through Wrought Iron Turntable, Cofrode & Saylor, Philadelphia, Pa.



Figs. 2 and 3. Sectional Views of Half-Through Turntable.

The next important improvement which will be made in turntables will be almost certainly the application of power to rotate them. We understand that the application of electricity to this work has already been canvassed by the Pennsylvania and one or two other leading railway companies, and tables equipped with electric motors are to be put in use at an early date.

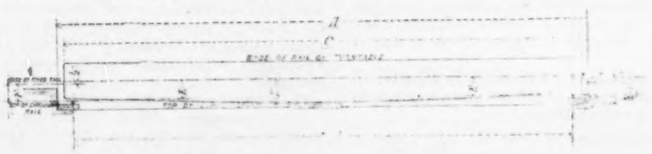


Fig. 4. Dimensions of Pits for Half-Through Turntables.

	ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. ins.
A. Diameter of pit	35—0	40—0	45—0	50—0	55 0	60—0
B. Diameter of track circle, *c.* to *c.* of rails	31—2	36—3	41—4	46—4½	51—5	56—5½
C. Length of girder, *o.* to *o*	32—9½	38—0½	43—3	48—5	53—6½	58—7½
D. Distance from base of rail on table to top of center stone	2—6	2—6	2—6	2—6	2—6	2—6
E. Distance from base of rail on table to top of circular track	1—11	1—11	1—11	1—11	1—11	1—11
F. Distance from base of fixed rail to top of circular track	1—10½	1—10½	1—10½	1—10½	1—10½	1—10½

Municipal Monopolies.

From the recently published work, "Monopolies and the People," we make, by permission of the author, the following extracts on the relations of the public to the corporations furnishing water, light, power, etc., to residents of cities:

From the peculiar circumstances of city life, many monopolies arise in production and transportation which occur nowhere else. One of these is the carriage of passengers on street and suburban railways. . . .

The power of this monopoly for harm is greatly intensified by the fact that its use is largely a necessity. In all our great cities the business sections are far removed from the residence sections, and the great mass of the industrial population is obliged to ride at least twice each day in going to and returning from work. In nine cases out of ten, there is one route so much more convenient than any other as to overbalance any slight difference of fare. Thus, even on the supposition that every different line was run in competition with every other line, the amount of really competitive business would be but a trifle. . . . The so-called street-railway trust, then, is really of no great moment. The monopoly in street-railway traffic arises from the nature of the business rather than from any especial effort of capitalists to kill competition.

The absolute necessity of a public water supply, and the practical impossibility in most cases that any competition in the furnishing thereof can be established and maintained, have led, in the case of most of our large cities, to the work of water supply being undertaken by the municipal authorities. But many of our smaller cities have intrusted to private companies the work of furnishing a water supply. While this is a case of real monopoly, yet under the conditions which may be enforced, most of the power for harm is taken away. According to the best plan in vogue, the city sells the franchise for constructing the works to the company who bids to furnish water at the lowest rates under definitely specified conditions, the franchise being sometimes perpetual, but oftener granting to the city at some future date an option for the purchase of the works. It is to be particularly noticed that this is a case in which the administration of an absolute monopoly has been intrusted to private enterprise with excellent results.

The author then devotes several pages to the discussion of the matter of gas supply. He explains the probable reason why the business is almost wholly in the hands of private companies. Only five cities in the United States own the plant for furnishing the city with gas. Reference is made to the attempts to establish competition in the gas business by granting franchises to rival companies. These have invariably resulted in the consolidation of the competing companies. The consolidated company has increased its stock by at least the amount spent on the duplicate and now useless plant of the rival company. The public has to pay interest on this sum and suffer besides the damage done to the pavements in tearing up and relaying.

The price of gas in the United States is discussed, and it is shown that the prices are very high in proportion to the cost of production.

It is then shown how the history of the gas monopoly is being repeated in electric lighting. The following, although written over a year ago, is quite apropos in view of the condition of the electric lighting industry in New York to-day:

The city of New York is taking every means to encourage the operation of rival electric-light companies, and is letting yearly contracts for street-lighting to the lowest bidder. It is true that competition is active just now, but it requires no far-seeing eye to discern the inevitable combination and consolidation among the companies.

Not only is competition of this sort sure to fail, but the attempt to establish it is very harmful. To say nothing of the expense and waste of wealth which is involved when rival companies are allowed to stretch their wires and establish their extensive central stations in the same district, it is everywhere acknowledged that the multiplication of wires overhead is a crying evil and danger. Are we to double and treble it, then, by permitting rival companies to place their wires wherever they please? It is evident that the temporary rivalry which we obtain in this way is bought at much too great a cost. What is true of electric-light wires is equally true of the vastly greater multitude of wires which belong to our rapidly growing system of domestic lighting, and the telegraph, telephone, and messenger service. Surely no man knoweth the beginning or the end of the network which is woven over our heads, and which, besides all the useful wires already enumerated, is full of "dead" wires, many of them strung by defunct or irresponsible companies, who would never have been allowed to obstruct the streets if they had not been "competing" for the business. Can there be any doubt that it is the height of folly to continue this work, and that the only rational way of intrusting electric service to incorporated companies is to permit but a single company to operate in a district and control prices by some other means than competition?

The necessity for this will be more rather than less apparent with the use of underground instead of overhead wires. The cost of placing wires in subways is far beyond the cost of stringing them on poles, and if we are obliged to build our subways large enough to accommodate all the rival wires which may be offered, we have a herculean task upon our hands.

Steam for supplying heat and power is beginning to be distributed from great central stations, through mains laid underground, to all parts of the surrounding dis-

triot. The necessity for frequent repairs and stoppage of leaks renders it necessary to break the pavement and dig down to the mains much oftener than is required for any other of our underground furniture. Nothing would seem more evident than that the number of these pipes to be laid should be the fewest consistent with the proper supply of the district, yet it is a fact that for a time two competing steam companies were permitted to run riot in the streets of lower New York, until the weaker one succumbed "to over pressure." Yet it is scarcely to be doubted that if another rival company were to ask for a permit to operate in the district now monopolized by the New York Steam Company, public opinion would tend to favor the granting of the permit "because it would give more competition." It is to be hoped that before these great systems for the distribution from central stations of various necessities reach much greater proportions, the public will become educated enough to perceive the folly of attempting to regulate them by competition. ....

We have already noted in the chapter on railway monopolies the injustice of permitting a single person or corporation to control and own any especially necessary means of communication, as a mountain pass or a long and expensive bridge, and the same principle is apparent in connection with the railway terminals in our large cities. The enormous expense attendant upon securing right of way for an entrance to the heart of the city makes it a very difficult matter for any new company to obtain a terminus there, except by securing running rights over the tracks of an older company. To give to any single corporation the sole control of the entrance to a city, and permit it to charge what toll it pleases for trains that pass through it, evidently places the city at the mercy of a monopoly. Practically the case is not so bad as this, as most large cities have means of water communication, and the railroads are run to the heart of the city through the public streets. But the time is fast approaching when these city grade crossings will be done away with, and in every city of importance the railways will enter the city on elevated viaducts terminating in a single union depot. Evidently it is contrary to the public welfare to sink more capital in these expensive structures than is necessary; and in general, several companies will use a single structure for entrance and exit. It is evident that the control of these terminals, if vested in a single company, may give rise to just the abuse we have set forth; and that the city itself should retain enough control over its railway terminals and freight-transfer lines to insure that no single carrier or combination shall monopolize them.

In the concluding chapter of the book, the author outlines the following plan for the control of municipal monopolies:

While it is in the highest degree desirable that waterworks, gas, and electric-lighting plants, street railways, and the other municipal enterprises discussed in Chapter V should be *owned* by the municipality, their operation, in cases where the employment of considerable labor and the carrying on of intricate business and mechanical operations is involved, should in general be entrusted to private companies. In every case where the financial condition of the municipality obliges it to rely at first upon private corporations for the construction and ownership of its public works, the franchise should expire at the end of a short term of years, and the city should then have the privilege of purchasing the works at their actual cost.

As regards works for water supply, there can be little doubt that almost invariably the municipality should operate as well as own the works, for the administration of the works requires but a small amount of labor, and that of such a class that the city can safely carry it on. But gas or electric-light plants, both for street and resident lighting, should be operated by private companies.

In small towns, it would doubtless be best to lease the plant for short terms of years to the highest bidder, making sure that the call for proposals is widely circulated. Great cities, however, would find this policy unsatisfactory. If a ten-year lease of the Philadelphia gas works, for instance, were advertised for sale to the highest bidder, there would be but few really close bidders upon it, and the danger of "a combination to defeat competition" would be great. It is at least worth considering whether such a plan as we proposed for railways could not be made feasible here. Let a corporation be chartered to operate the lighting plant of the city, and let the charter of the corporation provide that its rates shall be such as to pay an annual dividend upon its capital stock (fixed by law and not changeable) equal to the legal rate of interest in the State. Provided that in no case should the rates be lowered unless the net profits in one year were more than 2 per cent. in excess of this rate, and that the excess for two consecutive years was more than 1½ per cent. in excess of this rate. Provided also, that in no case should the rates be raised unless the deficit exceeded 1½ per cent. in any year, and 1 per cent. for two consecutive years, and that it should be proven by the company that it had exercised all reasonable diligence, care, and economy in the management and operation of its business.

A certain proportion of the stock—less than a majority—should be held by the city; and the mayor should appoint directors to represent the city, at least one of whom should be personally conversant with the industry carried on by the company.

Our municipal monopolies are now taxing us that they may pay swollen dividends on millions of dollars of fictitious capital. It is quite time that the public recovered possession of the valuable franchises which are its rightful property, and managed them for its own benefit. The legal difficulties in regaining the title to these franchises are certainly not insuperable, and the readjustment of capitalization can be made on the principle already outlined in the case of steam railways. To illustrate: The city of "Polis" purchases the works which supply it with water from the private company owning them, paying the average market value of the stock and bonds during five years past, which amounts, perhaps, to one and one half times the cost of the works. The revenue from the works has been sufficient, probably, to pay 8 per cent. on these securities. The city issues 3 per cent. ten-year bonds to raise funds for the purchase, and it then operates the works so as to gain a yearly revenue of 6 per cent., or 2 per cent. less than that gained by the private company. At the end of ten years the surplus income from the works is enough to pay more than one third the bonded indebtedness; and, if desired, the rest may be reissued as new bonds to run for a long period.

PUBLICATIONS RECEIVED.

—*Interstate Commerce Commission Report. Deductions from Weight of Wheat Delivered at Elevators.*

In this case the real question which it was sought to have decided was the right of railway companies to deduct 5 to 10 lbs. per load for shrinkage in wheat received from farmers at the elevators. As the complaint failed to prove that the commerce affected was interstate or that it was in violation of the law, the complaint was dismissed without prejudice.

—*American Isthmian Canal Routes.* By DANIEL AMMEN, Rear Admiral U. S. N. Reprinted from the Journal of the Franklin Institute. 1889.

This is a brief but interesting resumé of canal history on the Isthmus for the past forty years, and the history of the Nicaragua route is especially set forth, commencing with its personal and political features, and concluding with its engineering advantages over other routes.

—*Contract for Metal Work for Completing the Cook Tower.* Public Buildings, Philadelphia, Pa., and Report of Architect, Report of Special Committee, etc., Philadelphia, Pa. Published by the Commissioners. 1889.

This document gives the contract and specifications for this tower, as signed on Sept. 24, 1889, with the Tacony Iron and Metal Company, of Philadelphia.

—*Report of the Citizens' Executive Committee* of Yuma County, Arizona, to the Senatorial Committee on the Irrigation and Reclamation of Arid Lands. 1889.

This is a very full report, with map, setting forth the physical and topographical features of the county with its climate, rivers, soil, irrigation facilities, etc. Included is a report on the Oatman Canon reservoir site, by Mr. J. B. STEIGER, C. E.

— *System of Sewage Disposal* in the Town of Framingham, Mass. Reports of the Committee on Drainage and Sewerage, detail of cost of construction, plans, etc. Compiled by Mr. WILLIAM A. BROWN, Clerk to Selectmen. 1889.

The plan recommended for disposal is by filtration in land, with sizes and grades of sewers, and other details and estimated cost of construction.

— *Everybody's Hand-Book of Electricity*, with Glossary of Electrical Terms and Tables for Incandescent Wiring. By EDWARD TREVERT. Damrell & Upham: Boston, Mass. Price, 25 cts.

— *Inventor's Manual.* How to work a patent to make it pay. By an experienced and successful inventor. 1889. New York: J. F. Davison & Co. Size, 5 × 7 ins., pp. 98.

— *Report of Proceedings of the Association of Dominion Land Surveyors*, at its Sixth Annual Meeting, held at Ottawa, Feb. 19, 20, 21, 1889. Price, 50 cts.

— *Tenth Annual Report of the Ohio Society of Surveyors and Civil Engineers.* Tenth Annual Meeting held at Columbus, O., Jan. 8, 9, 10, 1889.

TRADE PUBLICATIONS.

—*Bucyrus Foundry and Manufacturing Co.*, Bucyrus, Ohio. The latest of their catalogues finely illustrated with photo-engravings of their shops, and the steam-shovels, wrecking cars, etc., made by this firm. It is a very creditable publication and sets forth much that is of interest to engineers and contractors.

—*Surveyors' and Engineers' Instruments.*—Illustrated catalogue and price list for 1890 by T. F. RANDOLPH. Cincinnati, O. Size 6 x 9 ins., 78 pp. including several pages of testimonials.

—*Calendar.*—The wall calendar issued by the Bicknell Advertising Bureau, of New York, has a fine tinted heliotype of Trinity Church, Boston, designed by the late Mr. H. H. RICHARDSON, architect.

—*Tools for Accurate Measurement.*—Advanced sheets of illustrated catalogue and net price list of calipers, rules, gauges, squares, tapes, scales, etc. C. B. JAMES, 98 Lake St., Chicago, Ill.

—*Condensed List of Optical Goods.* T. H. MCALLISTER: New York. Aluminum opera and field glasses are included in the list.

—*Screw Machines.*—Illustrated catalogue of the Brown & Sharpe Mfg. Co., Providence, R. I., Size, 9 x 5¾ ins.; 43 pp.

SOCIETY PROCEEDINGS.

Engineers' Club of Philadelphia.—Record of regular meeting, Dec. 21, 1889. President WILLIAM SELLERS in the chair; 21 members and 3 visitors present.

The Secretary presented, for Prof. W. H. BURR, "Some Notes on the Application of Electric Motors to Elevated Railway." The author states that this paper is not designed to advocate any particular system, but to provoke discussion of the subject. He shows that there are no greater difficulties in the way than have been overcome on surface lines, and that no insurmountable engineering problem exists in connection with the application of electric power to lines on elevated structures. He notes the advantages obtained in an electric locomotive on account of the absence of reciprocating parts in the wheels, thus avoiding the shocks and vibrations of the elevated structure which are consequent upon the use of the counterbalanced drivers of the steam-engine. These are but a few of the reasons given by the author to show that this system of transit may be made a perfect success.

The Secretary presented, for Mr. G. W. CHANCE, a paper upon "Right of Way." The author notes the importance of this subject in view of the enormous growth of our railroad systems and their immense landed interests. The paper is divided, first, into "Method of obtaining Originality," and this part of the subject is subdivided under the heads of "Location Surveys" and "Legal Papers." The second division of the paper is "Correcting the Originality of the Original," which is subdivided into "Re-surveys" and "Re-examination of Old Papers." Re-surveys is again subdivided into "Field Work" and "Office Work."

Mr. JAMES CHRISTIE presented "Notes on Riveted Joints." He confined his remarks entirely to single riveted lap joints as commonly used in the circular seams of steam boilers, and gave a history of a series of experiments, an analysis of which shows, he states, that an increase of efficiency was found to be due to the clamping force exercised by the riveted heads, with possibly a slight gain due to better bearing service, and that no instance was known of this binding of the joint, due to increase of rivet area, failing to show an enlarged resistance to rupture.

Mr. ARTHUR MARICHAL presented, for himself and Mr JOHN C. TRAUTWINE, Jr., a translation from the French of a pamphlet published by the prominent hydraulician, M. BAZIN, giving the results of very extensive experiments on the "Flow of Water over Weirs." The pamphlet explains in details the method of gauging, and describes the instruments used for that purpose. It gives the results of several hundred observations, and from these results are deduced co-efficients, which will be found very useful to engineers in charge of gauging operations.

The Secretary presented, for Mr. WALTER S. CHURCH, Some Suggestions About Testing the Strength and Tightness, and Relating the Carrying Capacity of the New Croton Aqueduct, N. Y." The object of this paper is to show the advantages and safety of delivering the much larger quantity of water through the Croton Aqueduct, which can be delivered if it is placed under pressure, than by gravity alone; that, at a reasonable outlay, its carrying capacity can be doubled, which would, he considers, ultimately double the commercial value of this great aqueduct.

Mr. H. EDWARD BROWN presented a paper upon the "Æsthetic Value of Engineering Constructions." He refers to the great material progress of the age, but asks, Is the man happier who is surrounded with material comfort than the man who, with perhaps less physical luxury, dwells in the midst of the most beautiful works of nature or of man? I doubt it, yet with the true Aryan instinct we Anglo Saxon people, in this latter half of the nineteenth century, are doing our best to allow the utilitarian to crowd out the æsthetic. We are making the world an ugly place to live in. Our loveliest valleys are defaced with the smoke of the iron furnace or the coke oven. Our most charming reaches of rivers scenery are spoiled by embankments raised along their banks, riprap walls along the shore, or straight, ungraceful plate girders of iron truss bridges spanning them. Straight across the country stretches an embankment or a cutting made by a railway in its progress. Its sides are naked earth or else overgrown by rank weeds, or, where perchance the

rocks may have been left by cutting through the mountains, they are defaced by some staring advertisement in glaring white letters, "that he who runs may read." He further says, "We might obtain the same results with harmonious, graceful lines, which would serve to bring out in greater strength the beauty so abundantly spread about us."

HOWARD MURPHY,
Secretary and Treasurer.

Engineers' Club of St. Louis.—At the meeting on Dec. 18, the ballot for officers for 1890 resulted as follows: President, F. E. NIPHER; Vice-President, GEORGE BURNET; Secretary, WM. H. BRYAN; Treasurer, CHAS. W. MELCHER; Directors, E. D. MEIER and S. BENT RUSSELL; Librarian and Manager, J. B. JOHNSON; Manager, J. A. SEDDON.

Col. MEIER read, as a retiring address, a paper treating of the advances made during the year, particularly in the directions of civil, mechanical, mining and electrical engineering. Instances of remarkable work done in these branches were noted. He also considered questions of local interest, the numerous engineering projects on hand in this vicinity, the World's Fair in St. Louis viewed from an engineering standpoint, the prosperity of the club and plans for its future, and the desirability of a closer union among engineers of the country.

The Secretary read a communication from the chairman of the Executive Committee of the Liederkranz, which body has undertaken the work of erecting a monument to Capt. JAMES B. EADS. The communication suggested the desirability of co-operation between the Liederkranz and the Engineers' Club of St. Louis, in the direction indicated. On motion it was ordered that the Committee on Eads Monument be increased to three, and the communication from the Liederkranz referred to them. Mr. ROBERT MOORE was appointed the additional member of the committee.

Prof. J. B. JOHNSON, Chairman, presented a report for the Committee on National Public Works; ordered that the report be accepted, and the committee discharged.

Mr. NILS JOHNSON showed the club a pump valve which had been operated under a pressure of 550 pounds for fifteen minutes with ordinary hydrant water.

WM. H. BRYAN, *Secretary.*

Boston Society of Civil Engineers.—Regular meeting December 18. President FITZGERALD in the chair; 39 members and 12 visitors present.

The committee to consider the advisability of urging upon the Legislature the necessity of printing an edition of the new map of the State for immediate use, submitted a report favoring such action, and the Society authorized the same committee to appear in its behalf and urge that a small number at least be printed at once.

Mr. WILLIAM E. MCCLINTOCK, City Engineer of Chelsea, Mass., read a very interesting paper describing three methods of heating and ventilating school buildings, which had been tried in that city. Mr. THEODORE P. PERKINS gave an account of methods of heating and ventilating which had been used in the school buildings at Lynn, Mass., and Prof. S. H. WOODBRIDGE, of the Institute of Technology, described a system well suited to small school houses. A general discussion upon heating and ventilating closed the meeting. Prof. THOMAS M. DROWN will read a paper on "Filtration of Natural Waters" at the January meeting.

S. E. TINKHAM, *Secretary.*

Canadian Society of Civil Engineers.—The nominating committee recommended the following for next year's council: President, JOHN PAGE, Ottawa; Vice-Presidents, JOHN KENNEDY, E. P. HANNAFORD, Montreal, H. F. PERLEY, Ottawa; Treasurer, H. WALLIS, Montreal; Secretary, Prof. H. T. BOVEY, Montreal; Librarian, F. CHADWICK, Montreal; Members of Council T. MONRO, Coteau Landing; P. A. PETERSON, F. R. F. BROWN, P. W. ST. GEORGE, K. BLACKWELL, E. H. PARENT, G. H. MASSY, F. R. REDPATH, C. R. W. DODWELL, Montreal, H. R. RUTTAN, Winnipeg, J. D. BARNETT, Stratford, W. T. JENNINGS, E. WRAGGE, Toronto; H. G. C. KETCHUM, Amherst; H. DONKIN, Port Hawkesbury, N. S.; W. P. ANDERSON, G. F. BAILLAIRGE, Ottawa; G. A. KEEFER, Vancouver, Sir I. W. TRUTCH, Victoria, B. C.; out of these 1 President, 3 Vice-Presidents, 1 Treasurer, 1 Secretary, 1 Librarian and 15 Councillors are to be selected. Ballots are to be returned on or before January 23, 1890.

An opposition ballot, signed by H. G. STANTON, E. MARCEAU, W. MCNAB, W. MCL. WALBANK, T. PRINGLE, has been issued, which proposes 6 new names for members of council, in lieu of some already nominated, viz., F. N. GISBORNE, Ottawa; C. SPROAT, Toronto; R. C. HARRIS, Kingston; H. S. POBLE, Stellarton, N. S.; P. S. ARCHIBALD, Moncton; J. S. UNSWORTH, Charlottetown, P. E. I.

A branch of the Society has been formed in Toronto with ALAN MACDOUGALL, President, and W. R. PILSWORTH, Secretary.

It is proposed to hold a summer convention. A special committee will report on this to the general meeting on Jan. 23.

Engineers' Club of Kansas City.—A regular meeting was held Dec. 2: Vice President FILLEY in the chair, KENNETH ALLEN, Secretary; present, 9 members and 4 visitors.

Minutes of the last Regular Meeting and those of the meeting of the Executive Committee were read and approved.

On canvas of ballots, THOMAS CALLAHAN was declared elected Associate.

The subject of "Sewer Ventilation" was discussed by Messrs. G. W. PEARSONS, H. H. FILLEY, F. E. SICKELS and K. ALLEN.

Mr. F. E. SICKELS then read the paper of the evening, on "Snow Plows," illustrated by models from actual practice and drawings.

The action of the best form of old-fashioned snow plow was to lift the snow to sufficient height and then throw to one or both sides of track by mould boards. It consisted of inclined plane with lower edge within 2 ins. of the track, with mould boards or wedges placed upon this, back of its front edge, far enough so that action of mould boards would be to throw snow on top of snow at side. If not over 9 ft. high, it may be placed on 4 wheels. Axles should be very large, having bearings 4½ in. diameter by 8 in. long, in boxes that can slide up and down in pedestal. Then if plow is heavily loaded (say 4 tons per wheel) it will do efficient service in ordinary storms. Accidents which have happened to this type of plow have mainly arisen from causes not inherent in the plan, but from the boxes being rigid in the pedestal and front end of plow striking, say, a mass of ice, lifting it up with the wheels, causing plow to leave track. The ordinary plow has been shown to be very effective in most cases, though the modern rotary plow is more effective in cases where snow and sand have drifted and frozen into a hard, compact mass.

The Annual Meeting was held Dec. 4: President O. B. GUNN in the chair; KENNETH ALLEN, Secretary; present 8 members.

The Secretary presented his annual report for the year.

During the year there have been held 1 annual meeting, 9 regular meetings, 2 adjourned meetings, 12 executive committee meetings.

ATTENDANCE.

	1889	1888.
Members—Total,	121	109
" —Average,	11	13
Visitors—Total,	54	84
" —Average,	4.9	6.5

Sixteen papers have been presented during the year, besides the general discussion of Sewerage at the November meeting. The annual banquet and a field meeting in September were notably pleasant features of the year.

The Committees on Bridge Reform, National Public Works, Transfer of Members, and Affiliation of Engineering Societies have done considerable work, but in each case developments from outside are awaited before further action is taken. A Committee on Cements and Mortars has been appointed, from which valuable information is expected in the future.

It remains to be settled in what way our representative on the Board of Managers of the Association of Engineering Societies shall be elected or appointed.

MEMBERSHIP.

	Honorary.	*Members.*	*Associates.*	*Associate Members.*
Dec. 5, 1888,	0	62	0	6
Additions,	3	17	2	3
	3	79	2	9
Resignations,	1			
Deceased,	1	10		
Dropped,	7			
Transf'd to other class,	1			
Dec. 4, 1889,	3	69	2	9

Non-resident Members, Dec. 5, 1888, 22
" " Dec. 4, 1889, 23

KENNETH ALLEN, *Secretary.*

Civil Engineers' Association of Kansas.—The third annual meeting was held at Wichita, on Dec. 18, and officers were elected for the following year: President, Prof. W. A. CHUISINBURY; 1st Vice-President, O. MULVEY; 2d Vice-President, R. W. LUTTRELL (Executive Committee); Secretary, J. C. HERRING; Librarian, H. H. JACKMAN; Treasurer, W. R. KESLER.

Michigan Engineering Society.—The eleventh annual convention will be held at Detroit, Jan. 21, 22, 23. The following papers will be presented: On Jan. 21: "Engineering," H. C. THOMPSON; "Long and Short Haul in Earth Work," O. C. GILLETTE; "Initial Work in the Mexican Boundary Survey," J. H. FORSTER; "Northern Boundary Survey," Prof. C. E. DENISON. Question box. On Jan. 22: "The Plane Table," Prof. J. B. DAVIS; "Bridge Inspection," B. DOUGLAS; "Progress of the St. Clair Tunnel," A. L. REED; "Photographic Surveying," Prof. R. C. CARPENTER; "Harbor Point Resort," GEO. E. STEELE; "Surveying in Oklahoma," O. H. TODD. Social evening. On Jan. 23: "Irrigation," Prof. L. G. CARPENTER; "Drainage of Huron Peninsula," F. F. ROGERS; "Our Laws on Drainage," WILLIS BALDWIN; "Means Employed in Running a Straight Line," GEO. L. WELLS; "Ypsilanti Water Supply," W. R. COATS. Paper by Prof. M. E. COOLEY. Question Box. Business: Nomination of officers, etc.

Civil Engineers' Society of St. Paul.—Regular meeting of Oct. 1, 1889, 13 present. Committee consisting of C. F. LOWETH, A. O. POWELL and J. D. ESTABROOK appointed to report on the proposed union of the local societies with the American Society of Civil Engineers. Paper read by Mr. C. J. A. MORRIS upon "The Dam for the St. Cloud Water Power Co."

Meeting of Nov. 4, 1889, 9 members present. Report of Committee on Affiliation with American Society of Civil Engineers read and discussed by members present, who agreed with the report of the committee, which was accepted and placed on file. This report in conclusion states in effect that the proposed union is not desirable as "We believe that the work to be done by the several societies is sufficiently broad and varied to give ample scope to separate organizations. Matters of universal or national importance will naturally go to the American Society of Civil Engineers, even if they are originally presented to some local society. The local societies can better attend to matters of local interest and such as pertain to the good fellowship of the profession. To burden the American Society of Civil Engineers with matters of only local interest would be unfortunate, while to deprive local societies of their home influence would be equally unfortunate." Mr. POWELL then read a paper on the United States laws relating to the bridging of navigable streams, giving requirements of said laws, references to the same, and a variety of information on the subject.

Meeting of Dec. 2d, 1889, 13 members present. The paper of the evening was read by Mr. F. FREYHOLD, upon "Methods of taking Topography over Extended Areas."

GEORGE L. WILSON, *Secretary.*

Liverpool Engineering Society.—The Sixth Ordinary Meeting of this Society took place on Wednesday evening, Dec. 11, at the Royal Institution. Mr. HENRY H. WEST, M. Inst. C. E., took the chair, and there was a large attendance of members. After the customary routine business had been disposed of, Mr. EDWARD T. WARD, Assoc. M., Inst. C. E., read a paper on "The Salt Industries of Cheshire." He gave a concise and clear account of the geological position and probable formation of the salt bed, and then passed on to review the history of the "working" "winning" and "getting" of salt from the earliest historical times, in its two forms as brine and rock salt. A vivid description of the method of mining the rock salt and bringing it to the surface was given by the speaker, who also supplied a sketch of the manufacture of "white salt" from brine, especially with respect to method of purification. The construction of saltpans, with their furnaces, flues, and stoves, was then described in detail, and Mr. WARD referred to the subsidences consequent upon the pumping of brine and the mining of rock salt, and in his concluding observations he gave an account of the present state of the trade under the Salt Union, on which he commented in favorable terms.

An interesting discussion then took place amongst those present, turning principally upon economies in the process of manufacture and upon the construction of the pans, and a vote of thanks to Mr. WARD for his paper terminated the proceedings."

New England Water-Works Association.—An adjourned meeting will be held at Young's Hotel, Boston, Mass., on Wednesday, Jan. 8, at 11 A. M. The rooms will be opened for the use of the members; at 12:30 there will be a meeting of the Executive Committee; at 1, lunch will be served.

The post-prandial exercises will consists of a series of brief experience papers. As each topic is to be selected by the writer thereof, there will be quite a wide range of subjects presented. Members are requested as far as possible, to incorporate in their annual reports a summary statement descriptive of the works under their respective charge, in accordance with the plan and recommendation adopted by this Association. A full description of this plan may be found in the transactions of 1885.

DEXTER BRACKETT, *President,*
221 Federal St., Boston, Mass.
R. C. P. COGGESHALL, *Secretary*
New Bedford, Mass.

Master Car Builders' Association.—The Executive Committee announces that it has selected Old Point Comfort, Va., as the place for holding the next Annual Convention, commencing Tuesday, June 10, 1890. The headquarters of the Association will be at the Hygeia Hotel, the management of which has named a uniform rate of $3 per day for all who attend the Convention. The Committee of Arrangements consists of Messrs. WADE, DAY DEMAREST, but members who wish, are to engage rooms in advance should address Mr. F. N. PIKE, Manager Hygeia Hotel, Fortress Monroe, Va.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York.

VOL. XXIII. Saturday, Jan. 4, 1890.

D. McN. STAUFFER A. M. WELLINGTON

EDITORS.

CHAS. W. BAKER E. E. R. TRATMAN M. N. BAKER

ASSOCIATE EDITORS,

GEO. H. FROST . . . . . BUSINESS MANAGER

SUBSCRIPTIONS.

To United States, Canada, and Mexico.

One Year, **$5 00;** *6 months,* **$2.50;** *3 months,* **$1.50;** *Single Copies, 12 cents. To all* **Foreign Countries** *in the Postal Union, add $2.08 to above prices for postage.*

CLUB RATES.

Two new subscriptions	$9,00
One renewal and one new subscription	9,00
Five new subscriptions	20.00
One renewal and four new subscriptions	20,00

Subscribers *can have the mailing address of their paper changed as often as they desire. Send both the old and the new addresses.*

The date *when the subscription expires is on the address label on each paper, the change of which to a subsequent date becomes a receipt for remittance.* **No other receipt** *is sent unless requested.*

Advertising rates. 20 cents per line *agate measure. Schedule sent on request.* **Changes** *of advertisements must be in hand on Tuesday afternoon;* **New** *advertisements Wednesday afternoon;* **Transient** *advertisements not later than Thursday noon. The last pages go to press early on Friday, and we will be obliged if parties who fail to receive their papers promptly will notify us without delay.*

Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty, or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

Coming Technical Meetings.

Engineers' Club of Kansas City, Mo.—Next meeting, Jan 6. Secy., Kenneth Allen, 200 Baird Building.

Civil Engineers' Society St. Paul, Minn.—Next meeting Jan. 6. "The Survey of the Northern and Northwestern Lakes." J. H. Morrison. Secy. Geo. I. Wilson

New England Railroad Club, Boston, Mass.—Next meeting, Jan. 8. "Notes on Foreign Travel." Rooms in the United States Hotel.

New England Water-Works Association.—Next meeting at Young's Hotel, Boston, Mass., Jan. 8.

Civil Engineers Association of Kansas, Wichita, Kan.—Next meeting Jan. 8. Secy. J. C. Herring, Wichita.

Civil Engineers' Club, Cleveland, O.—Next meeting, Jan. 14 Secy., C. O. Palmer, 22 Cedar Ave.

American Society of Civil Engineers, New York.—Annual meeting, Jan. 15. Secy., John Bogart, 127 E. 23d St.

Engineers' Club of St. Louis, Mo.—Next meeting, Jan, 15. Secy., W. H. Bryan, 809 So. 7th St.

New York Railway Club.—Next meeting, Jan. 16. Rooms at 113 Liberty St.

Engineers' Club of Philadelphia, Pa.—Next meeting Jan. 18 Secy., Howard Murphy, 1122 Girard St.

Michigan Engineering Society—Annual meeting at Detroit, Jan. 21, 22, 23 Secy., F. Hodgman, Climax, Mich.

Western Railway Club, Chicago, Ill.—Next meeting, Jan. 21. Rooms in the Phœnix Building.

Engineers' Society of Western Pennsylvania.—Next meeting, Jan. 21. Secy., S. M. Wickersham, Pittsburg, Pa.

Boston Society of Civil Engineers.—Next meeting, Jan 22. Secy., S. E. Tinkham, City Hall.

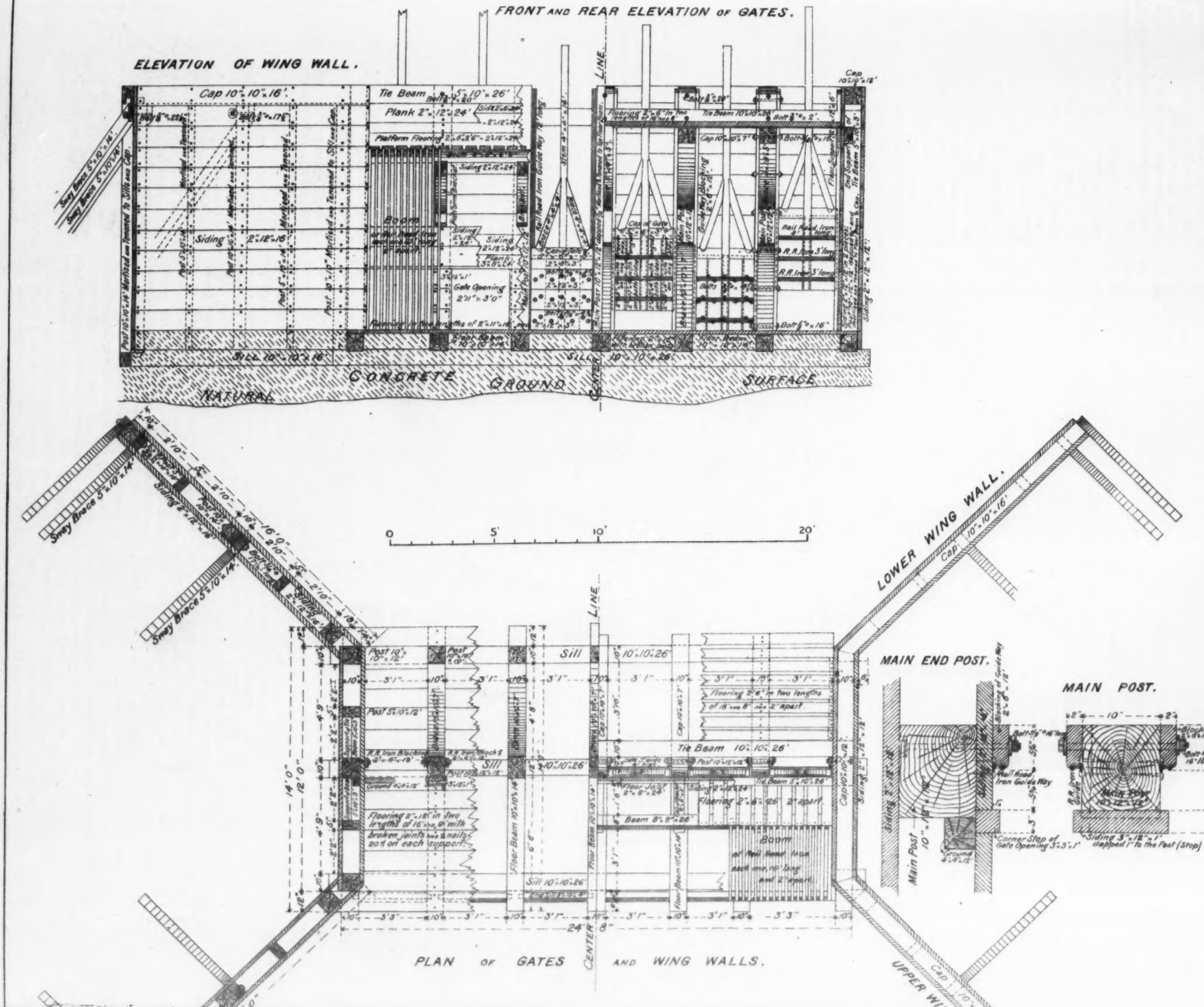
THE opening of the last decade of the century, as it will be generally thought of (the last decade does not really begin for a year yet, but few will realize that fact), cannot but awaken gratified reflections on the present marvellously accelerated rate of progress of mankind in every element of civilization, and especially in scientific knowledge and in material wealth and comfort. So far, this advance has gone on in accelerated ratio from decade to decade, even within this century, and it may well be—nay, it probably will be—that the last decade will be the most notable of all in this respect. All the conditions are favorable for it. The peace of the Western Hemisphere, at least, seems more certain than ever before to be preserved for an indefinite period. In the Old World, the chances for peace are at least as good as they ever have been. War is getting so enormously destructive and burdensome that peace bids fair to be enforced by the very success of the efforts to make wars deadly and decisive. As the entire abandonment of personal armor was caused by the introduction of firearms, so the entire abandonment of national armor in all its forms may well be enforced within the next decade by the terrific energy of the destructive engines which the ingenuity of man is creating. For example, it only needs a very little more progress in dynamite and submarine torpedo boats to make the putting of great war ships afloat simply an invitation to sudden and complete destruction. Electricity and chemistry are advancing with giant strides, and it needs no prophet to see that a little more advance will make naval wars at least impossible, by so strengthening the means of defence as to convert naval warfare into wholesale murder.

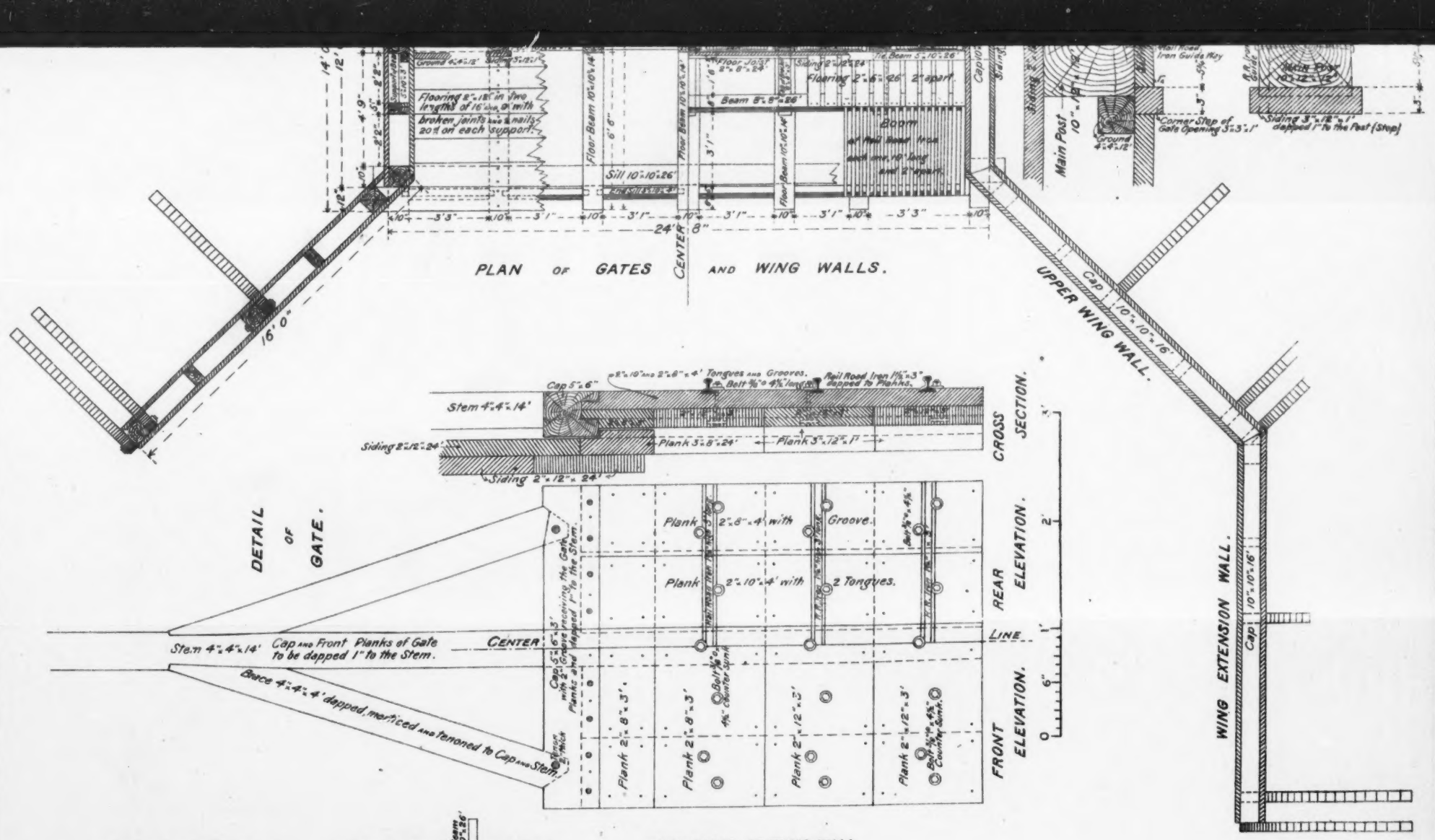
IT is a great temptation, at this season, to enlarge upon this theme, and especially upon the rate of progress in the great engineering arts on which our civilization mainly rests; but as we cannot now attempt to do it thoroughly we will not attempt to do it at all. One fact only is worth noting,—that, great as were the seeds of progress sown in the first half of this century, the achieved results of the century have been so overwhelmingly greater in the last half that they may almost be said to date from 1850, or even from 1860. As one evidence of this, there did not even exist an engineering journal in the world, worth speaking of, until *The Engineer* was started, in 1856. Its worthy rival *Engineering* was not started till 1866, and curiously enough, by an American, ZERAH COLBURN. Our own journal was not started until 1874, and in any equivalent to its present form may be said to date from 1883 only. What its progress has been since we need not say—at least we will not say—but leave the paper to speak for itself. But as we cheerfully recognize the fact that its progress is due far less to any merits of its editors and managers than to the rapid advance of the engineering interests of which it is the organ, making its progress in a measure an index of the progress of those interests, we have an especial and double satisfaction in finding that there is yet no sign of falling off even in its rate of progress. As one practical evidence of this: Our readers will (some of them) have noticed that each recent issue has been accompanied by an inset sheet of plans or maps, and sometimes by two such insets. This will be a regular feature of each issue hereafter. We find it quite impossible to properly cover our field without them. We should not do this if we thought we should lose money by it in the end, but it practically amounts to a gift of nearly $1 per year to each of our subscribers, so that they can judge that the outlook for engineering interests and ENGINEERING NEWS seems to us fairly satisfactory. We are thankful that we can (as we heartily do) wish to all our readers A Happy New Year, feeling that, in a material sense at least, it will be their own fault if they do not have it.

MAYOR GRANT charges Street Commissioner COLEMAN with "flagrant failure" to perform the duties of his office, and the Commissioner has resigned in a letter which practically ascribes his removal to political rather than to sanitary reasons. Just to what degree politics is mixed up with this variance of opinion regarding the condition of the streets of New York it is not for us to say; but every one does know that the streets are shockingly dirty, and the head of the department charged with the duty of keeping them clean must be held responsible for their present condition. If the Street Cleaning Department is not alone to blame for the dirt justly complained of, as Commissioner COLEMAN says, it is time that this department was reorganized on a more efficient basis.

In a notable article in the *New York Evening Post* it is shown that certain parts of Broadway and 23d Sts. are kept clean by private contract in consideration of $1.00 per week paid for every 25 ft. frontage; and what is more, Broadway in the part affected, from 17th to 22d Sts., is in most admirable condition in all seasons. The contractor for this work is said to be a man of abundant experience and to be engaged in conducting similar operations in Brooklyn and Philadelphia. If his estimates are correct, he could on a large contract make a round profit on a payment of 10 cts. per 25 ft. frontage, and this latter figure would aggregate for the whole city just about what is now expended in so called street cleaning by the city department. There is a notable difference in the methods, however, as well as in the results arrived at under the two systems. Private contractor BYERS employs only able-bodied men and will not employ a man sent to him by a politician under any circumstances; and his men are constantly at work, sweeping the streets by night and at once removing the refuse, and all day long other men patrol the steets and by the bag-system remove all refuse as fast as it appears. The key to success in this case is an honest effort on the part of the contractor to perform his full duty, and the continual service of his employés.

STREET cleaning by private contract on a large scale has been tried before, both in New York and Philadelphia, and it has always ended in lamentable failure both in economy and general efficiency; but the reason therefor is plain enough. Instead of the honest work now performed on Broadway, for private paymasters and under their personal inspection, in the cases mentioned it took but little time for the municipal faction to transform the working force into a political pension bureau and the contractors into second-rate political leaders. It was practically the same condition of affairs which exists in the public departments, where every employé regards his position as a reward or bid for political service. Politics and good work never will mix well together; and it is after all merely a matter of form whether our streets are cleaned by private contract or by the direct employés of the city. Honest, constant work, under rigid and intelligent supervision, is the only thing that will keep our streets really clean; and the one remedy that we can suggest is to remove this service out of the realms of politics by reorganizing it on a basis as near as possible like that of our present police system. Put a good man at the head of it and keep him there during good behavior, and let master and man understand that efficient work is the only measure of permanent employ. Clean streets are only second in importance to well guarded streets in our municipal organization; and the plan that has worked so well in the one case ought to be equally efficient in the other, if an honest effort is made to put a really satisfactory plan in operation. As Mayor GRANT now poses as the champion of the rights of citi-


FRONT AND REAR ELEVATION OF GATES.
ELEVATION OF WING WALL.
CENTER LINE
Cap 10"×10"×16'
Tie Beam 5"×10"×26'
Plank 2"×12"×24'
Platform Flooring 2"×6" 2'6"
Siding 2"×12"×16'
Boom
Gate Opening 2'11"×3'0"
Sill 10"×10"×16'
Sill 10"×10"×26'
Snay Brace 5"×10"×14'
Floor Beam 10"×10"×14'
Floor Beam 10"×10"×26'
Cap 10"×10"×12'
Flooring 2"×6" in two lengths of 16' and 8' with 2" apart
Tie Beam 10"×10"×26'
Bolts 3/4"×2'
Bolts 3/4"×16"
Cap of Gate
Guide Way Blocking 12"×6"×28"
Rail Road Iron Guide Way
R.R. Iron 3' long
Bolts 7/8"×16"
Floor Joists 2"×6"×24"
Floor Beam 8"×8"×26'
Siding 2"×12"×24"
Flooring 2"×6"×26' 2" apart
Beam 8"×8"×26'
Boom of Rail Road Iron each one 16' long and 2' apart
Flooring 2"×12" in two lengths of 16' and 8' with broken joints and 4 nails 20" on each support
Post 10"×10"×12'
Post 5"×10"×12'
Post 10"×10"×14'
Sill
Ground 4"×6"×12"
R.R. Iron Blocking 8"×6"×18"
Snay Brace 5"×10"×14'
Siding 2"×12"×16'
Siding 2"×12"×24'
Plank 3"×12"×24'
Gate Opening 2'11"×3'0"
Bolts 7/8"×22"
Bolts 3/4"×17"
Bolts 3/4"×16"
Bolts 7/8"×16"
Bolts 3/4"×2'
Bolts 3/4"×2'6"
Bolts 7/8"×16"
Bolts 7/8"×18"
Bolts 7/8"×20"
Bolts 7/8"×22"
Bolts 7/8"×24"
Bolts 7/8"×26"
Bolts 7/8"×28"
Bolts 7/8"×30"
Bolts 7/8"×32"
Bolts 7/8"×34"
Bolts 7/8"×36"
Bolts 7/8"×38"
Bolts 7/8"×40"
Bolts 7/8"×42"
Bolts 7/8"×44"
Bolts 7/8"×46"
Bolts 7/8"×48"
Bolts 7/8"×50"
Bolts 7/8"×52"
Bolts 7/8"×54"
Bolts



HEAD GATES AND BOOM OF MAIN CANAL, AT DOLORES, COLORADO.

COLORADO WATER SUPPLY CO.

W. H. WELLS, CHIEF ENGINEER.

CHAS. HART & SONS, LITH. 38 VESEY ST. N. Y.

zens in this matter, we venture to hope that he and his friends will bring about a radical reform somewhat on the lines indicated. A little less Tammany vs. County Democracy and a little more organized muscle would work wonders in cleaning our streets.

THE Engineers' Club of Philadelphia is again having a difficulty over the coming election for officers, and the parties at the bottom of it are apparently the same members who about a year ago urged the adoption of a resolution depriving non-resident members of the voting privilege. We understand that this opposition is against the present Secretary of the Club, who in some manner has made himself obnoxious to a certain combination within the membership. But the ground upon which this opposition is nominally based is frivolous in its nature and above all lacks the essential element of truth. It is said that the Club has ceased to be prosperous and that the publication of the *Proceedings* is delayed by the "multiplicity of professional engagements" of the present Secretary. This is certainly news to many members of the Club, and to many others who are not members, but who have always regarded the Engineers' Club of Philadelphia as the most active and prosperous of engineering societies, outside of the American Society, and have further ascribed very much of this prosperity to the energetic and efficient supervision of its Secretary, Mr. HOWARD MURPHY.

In looking over the history of this Club we find that when Mr. MURPHY became its Secretary, about ten years ago, it had 81 members, two small rooms for meeting, and with difficulty met an annual expenditure of $300. According to the last report, the club now has 482 members, a large and excellently appointed club-house, library, etc., publishes its own *Proceedings*, spends $4,032 per year, and has no debts. This hardly proves that the Club is going down hill, but it does prove that the Secretary, who is the working man in all similar organizations, must be an unusually good and efficient officer to so keep up the standard and encourage the growth of the Club, and yet find time for "the multiplicity of professional engagements" complained of by the opposition. Men who can accomplish so much work in a given time are rare, and it would seem to be decidedly an inexpedient and dangerous thing to attempt any change so long as this "busy" man sees fit to stand as a candidate for the office. It is inevitable that there should be an opposition party in all clubs of any importance or size; but if the present opposition shows no more strength than it did lately in trying to concentrate power by shutting out a letter-ballot, there need be little apprehension. Judging by this one defeated object alone, it would be very unfortunate for the Club if this opposition gained control; for it would be but natural to follow the election of a Secretary of their choice by a renewed attempt to curtail the voting privileges; and if this did not mean the dissolution of the Club, it would certainly speedily reduce its power and usefulness by occasioning the resignation of the majority of its membership. The personal animosity shown in the present attempt to deprive the Club of an officer of well-tried ability is most unfortunate, and every well-wisher of the Engineers' Club of Philadelphia will unite with us in wishing that this effort may meet a well-merited rebuke in overwhelming defeat.

Mr. BRECKINRIDGE, of the House of Representatives at Washington, has again called up his Bill for creating a Bureau of Harbors and Waterways, which bureau is to take charge of all public improvements of a civil nature, and which is to be officered by a corps of United States Civil Engineers. We have already commented upon this bill at length, when first presented, and will only now repeat that the great importance of our public works and the amount of money annually expended upon them makes us decidedly favor a bill which is a first step in the direction of a reorganization of the control and manner of conducting this work. The provisions of the bill seem fair, and provide for a continuance in service of the army officers who have done such good work in the past; but it also metes out tardy justice to the civilian employés in the matter of relative rank and general advancement.

Probably the very best, if not the most important, provision of this bill is the clause forbidding the commencement of any public work until a sufficient appropriation is made to complete it. A few notable cases are excepted, but the general tendency of this clause would undoubtedly be a direct economy to the Government, and result in better work everywhere. Many insignificant and utterly worthless "improvements" would not be authorized at all, were it known at the start how much they were to cost, and what relation their general public value bore to the expenditure required. This part of the bill might interfere, in many cases, with a Congressman's idea of the services due to his constitutents, the payment of certain obligations with public money; but the general public would greatly gain thereby. One other provision of the bill, though just in itself, seems likely to meet with considerable opposition; that is the proposed retirement on half-pay of civil engineers employed by the bureau on reaching the age of sixty-five years. The valid objection is made that this is establishing a precedent that could apply as well to other civilians in Government employ, and that it is contrary to the established practice of the Government, which has strictly confined its retired list to the army and navy, even to the exclusion of the Revenue Marine Corps. Many arguments might be advanced in favor of the proposed retirement of engineers, but this provision should be left to the wisdom of our law-makers and in no wise allowed to interfere with the other and more vital provisions of the bill.

The theory that the Gulf Stream is responsible for our abnormal weather, by hugging our coast closer than in past years, is denied. It is pointed out that the warm current issuing from the Gulf of Mexico can only affect the weather by conveying heat and moisture to the air overlying it, and then transferring these conditions to the land by air currents. But the truth is that the prevailing winds passing over the Gulf Stream blow toward the northeast, and away from our coast. They modify the climate of northern Europe, just as the air passing over the Japan current gives a mild climate to British Columbia and California. Of course, at times, we have southeasterly winds, and the temperature and rainfall of the Atlantic seaboard is materially affected thereby; but the difference of a hundred miles or more in the position of the Gulf Stream would have in itself little effect on our home climate. The distribution of barometric pressure and marked departures from normal pressure, from whatever cause they may arise, are much more likely to bring about abnormal weather, and we must study these changes rather than the ever winding and waving Gulf Stream.

New York City's Rapid Transit Facilities.

For a long time now, the question of rapid transit facilities for New York City has been a most important, if not the most important, subject relating to the city's prospective growth and development. Various plans for deep and shallow underground tunnels and high and low elevated structures have been presented and advocated; but none of them seems nearer success now than two years ago. The fact appears to be that, since the cities of the State have been given power to control the passenger traffic within their borders and to claim a share of its earnings, there is no longer a prospect of anything more than reasonable profits to the projectors of new rapid transit lines; and the certainty of even that in this city has not as yet seemed great enough to induce capital to undertake any of the various schemes which have been presented.

When private capital will not take the initiative, the only hope of progress is for the city officials to take the lead. But between the demands of political factions, the inevitable red tape of official action, and the necessity of securing some degree of harmony and unanimity in the adoption of plans technical and financial, the prospect for the construction of a real rapid transit system in this city seems no better now than it was many months ago.

This is not a wholly deplorable state of affairs. The city is even now better supplied with transit lines than any other large city of the United States; and when any new ones are built, it should be on some carefully worked-out plan which will command at once the confidence of capitalists and the approval and co-operation of the city authorities. It will be far better for us to wait a few years and get along with our overcrowded cars as best we can, than to turn over free to a private monopoly the new transit lines, or to submit to any cheap temporizing with the transit problem, like an elevated road on Broadway, for instance.

But even if a plan for new transit lines were matured and adopted this winter,—of which we see no signs at present,—it would be a practical impossibility to complete such a substantial railway as this city's traffic demands in time for an exposition in 1892. Indeed, remembering the delays which will be inevitable in executing such a work, either above or below the crowded streets of New York, there seems no reason to expect that our prospective new transit lines will be in operation in less than four or five years, while it is not impossible that another decade may close before their completion.

Certainly no efforts of public-spirited citizens to hasten the movement for real rapid transit should be relaxed; but as a delay of some years is inevitable in any case, it seems well to inquire what means can be taken to enlarge the capacity of our present transit lines, and make our situation fairly bearable until relief comes. The necessity for doing this will be still more apparent in case New York should be the site of a World's Exposition in 1892; but in any case, the present overcrowded state of our cars, and the fact that much traffic is not accommodated by the present companies, is reason enough for increasing present facilities.

We referred in our issue of Nov. 16 to the relief which will come by the adoption of the cable system for the surface cars on Broadway and Third Avenue. This relief will be still more marked if the Eighth Avenue,

Fourth Avenue, and perhaps the Sixth Avenue surface roads also adopt the cable system, as they will be quite likely to do to follow their competitors. But no very great gain will be made in speed by the cable system in New York's crowded streets, over that now made by horses. It will take a considerable time to get these cable lines in operation; and the extra accommodation they will furnish is likely to be taken up as soon as it is ready, with little appreciable decrease in the rush of traffic on the elevated railways.

Some feasible means of increasing the traffic capacity of the elevated railways, therefore, is the problem to be solved; and it is a problem of exceeding interest to engineers in general, as well as to the stockholders of the Manhattan Elevated corporation, and to the people of New York, whose daily business is absolutely dependent on the facilities afforded by the elevated roads.

It may be as well to settle the question in the first place as to the future of this corporation. It has been argued, we believe, that if new and permanent rapid transit lines sufficient for the needs of the city were constructed, the Manhattan Elevated corporation might be dissolved and its structures removed from the streets. But however desirable such a thing might come to be, there seems little prospect that it can be effected, at least for many years. The company is in lawful possession of its property and franchises. It is making itself still more secure by paying, according to law, the damages to property along its lines caused by the operation of its road. The accommodations it affords to local travel are likely to be needed even with a real rapid transit line in operation from the Battery to Harlem; and there would be great opposition to its removal. Finally, the twenty or thirty million dollars invested in the structures of the company should not be destroyed unless manifest necessity requires it.

Considering it settled, then, that the elevated roads are here to stay, let us inquire what steps can be taken to secure the best possible service to their patrons. It is to be remembered, in the first place, that the daily operation of the elevated roads is absolutely necessary to the transaction of business in this city. To suspend the operation of any one of the lines for a day or two is of course possible, but it strains the carrying capacity of all other transit lines to their utmost; and if a suspension for any length of time were necessary, some other means of transit would have to be provided in its place.

Let us now see what is the present capacity of the elevated roads and how their traffic is growing. The following table shows the train mileage and passengers carried for four years. The fiscal year of the company ends Sept. 30.

Year	Passengers carried	P. C. Increase over preceding year	Train mileage	P. C. Increase over preceding year
1886	118,190,591	11.4	6,635,460	4.7
1887	158 963 232	38.1	7,230,799	9.0
1888	171,529,789	7.9	7,584,572	4.9
1889	179,497,433	4.6	(Unknown)	(small.)

Residents of this city do not need to study figures to know how much faster the traffic of the elevated roads has grown than the train mileage, but those who study the problem at a distance will be helped to appreciate the conditions of the problem by the above table. The traffic on each of the lines for the past two fiscal years was as follows:

	1888	1889	Increase
Second Avenue Line	32,200,953	33,111,925	880,972
Third Avenue Line	68,308,460	69,924,730	1,616,270
Sixth Avenue Line	53,115,965	58,329,410	5,213,445
Ninth Avenue Line	17,814,411	18,131,368	317,957

It thus appears that the actual increase in traffic last year was only two-thirds what it was in 1887; this notwithstanding the strike on the surface roads and the Washington Centennial, each of which occurrences for a short time greatly increased the company's traffic. On the second day of the Centennial celebration, 825,000 persons were carried by the elevated roads. It is quite certain that the growth in traffic on the elevated has already been seriously checked by the insufficient facilities offered. The rapid growth of the New Jersey, Staten Island, and Long Island suburbs of New York City, and even of Brooklyn, despite its bad bridge facilities, indicates that the crush on the elevated roads is diverting home-seekers from the upper part of Manhattan island to places which they can reach more easily and comfortably.

It is, therefore, plainly for the interest of the Manhattan Elevated Company to adopt any feasible plan for increasing the capacity of its road. That such an enlargement would greatly conduce to the comfort, health, and good temper of the quarter of a million New Yorkers who are obliged to ride daily in the elevated trains, it needs no argument to prove.

The method which is adopted on ordinary roads to increase capacity—increasing the number of trains—cannot be pursued much further here with safety. Trains in the rush hours are run as close as is wise on the Sixth and Third Avenue lines at least. An increase on the Ninth Avenue might be made except for lack of terminal facilities, the road being really a loop of the Sixth Avenue line and using the same terminals. Besides, the Ninth Avenue cars are less crowded than those on any other line.

The only feasible method of solving the problem, therefore, is by increasing the capacity of each train. The 5-car trains, now run on the Sixth and Third Avenue roads, when fully loaded, are as heavy as the present locomotives can pull, in fact rather heavier in case of snow on the rail, as the blockade during the blizzard of 1888 proved most unpleasantly. It is also noticeable that with the locomotives pulling so nearly their full load, the trains are much slower in getting under way. A surprisingly large percentage of the round trip is occupied in getting up speed, and since the time taken for a round trip is an indirect factor in the capacity of the road (the controlling factor being the number of trains passing a given point, regardless of their speed, any possible gain in this regard is of much importance.

One plan proposed for solving the problem is to increase the capacity of the present cars. Two-story cars or cars considerably wider might be used. The use of either would necessitate an expense of three or four million dollars in reconstruction of stations and rolling stock. Either style of car would be apt to scare timid passengers in rounding curves, and not without reason perhaps. The gain in capacity by wider cars would not be very great. The gain in capacity by two-story cars would be considerable; but on rainy days the dripping from the upper platforms would be a serious nuisance. From the operating point of view, the additional weight of either type would be no trifling matter, and might make it necessary to cut down the maximum train to four cars.

As the obstacles in the way of improvement in this direction seem so nearly insurmountable, we are confined to the plan of adding more cars to each train. This would have been done long ago, and heavier locomotives would have been put on to draw them, but the elevated railway structure was not designed to carry locomotives heavier than those now in use; and the problem resolves itself therefore into either a possible means of propelling longer trains without increasing the weight of the motor, or a reconstruction of the present elevated structure.

Regarded as an engineering question, merely, there is very much to be said in favor of the latter plan. If the elevated roads were now to be built, completely new, they would be much more solid structures than the existing ones and much better designed to resist lateral strains and vibration. Plate girders would replace the present lattice girders; and a moving train would not make the whole structure shake for an eighth of a mile ahead of the locomotive. No such rebuilding of the structure is at all likely, however. If the Manhattan Elevated Company were assured a continuance of its present monopoly and undisturbed possession of its franchise for as much as twenty-five or thirty years to come, it might rebuild its structure; but no such certainty as to its future exists. It would, indeed, be a most shrewd policy for the company to pursue, to rebuild its structure and increase the capacity and comfort of its trains to such an extent that the public in general would cease to take any interest in the movement for real rapid transit; but that the company intends to pursue such a policy, no one believes. If the company were to adopt heavier engines on their road, they would probably confine their efforts to strengthen their structure to the patching and piecing-on process, which has been already pursued. There would be some considerable difficulties in entirely rebuilding the structure without interrupting traffic.

It seems, then, altogether probable that the only hope of materially increasing the capacity of the elevated roads is by some method which will bring no increased weight on the structure and which yet will permit trains of six, seven, or more cars to be run; but having taken so much space in settling the preliminary questions necessary to reach this conclusion fairly, the discussion of the different feasible plans of accomplishing this must be postponed to a following number.

M. C. B. and Other Automatic Couplers.

We publish in another column a letter from Mr. R. C. BLACKALL, Superintendent of Machinery, of the Delaware & Hudson Canal Co., which is notable as the first letter which has reached us from any high mechanical official, out of a pretty large correspondence on this subject, in which the M. C. B. type, as a type, has been condemned as inadequate and unsuitable. Mr. BLACKALL justly remarks that "honest opinion based upon practical experience, and a knowledge of the inherent defects of the type you champion is surely worthy of respectful recognition," and proceeds to make a severe attack upon the M. C. B. type, on its merits.

Whether the grounds of attack be sound or unsound, such opposition is to be expected, nor is it to be regretted. Opposition is necessary to healthful progress in mechanical as in political matters. But there comes a point at which opposition becomes merely "stubbornness worthy of a better cause," and the only question is: Has that time now arrived? We cannot but feel that Mr. BLACKALL's letter itself contains evidence that this time has arrived.

We published in our issue of Dec. 21, 1889, a map showing graphically the present status of the introduction of automatic freight train brakes and couplers, which we need hardly say makes a very remarkable showing of rapid progress in what must plainly be generally believed to be a great reform, as no company is making the large expenditures involved for any other reason. To what i

this activity to be ascribed? The natural inference from the facts is that it is the result of accumulated favorable experience with the M. C. B. type, leading no prior believers in it to abandon it, but a flood of new adherents to come in. This is the way in which most or all great improvements are introduced, very slowly and tentatively at first, but afterwards at a greatly accelerated rate. Such has been the outward course of events, at least, with the M. C. B. type of coupler.

For what are the facts as to automatic couplers? For the past ten years at least it has been a very live practical question; for twenty years it has been felt that some reform must come. Up to 1880 the link type was decidedly the favorite. The Ames link coupler was already very largely in use on the Lake Shore & Michigan Southern Railways; other link couplers were being tried on other railways; the badly named "vertical plane" type had not even been heard of for freight use; and in fact the Janney coupler, which has been the founder of the whole type, as a practical question was just fairly established as a passenger coupler.

We may even add, as a fact of great interest in this complex question which has never been made public before, that nothing but the merest chance (absurdly exaggerated demands by the inventor) prevented the Ames link coupler from being adopted as a standard by the West Shore Railway in 1882. Had it been so adopted, it is quite within the possibilities that this would have settled the whole matter; for the Ames was a good coupler, and the West Shore was so well known to "go in for the best," regardless of expense, that it might have become just the needed center for general practice to crystallize around. There was still no "vertical plane" freight coupler even talked about for general use.

The first formal action on the subject by the M. C. B. Association was in 1884, when nine couplers were recommended for further trial, seven of them being of the link type, and two only, the Cowell and Janney, of the "vertical plane" type; so that the link type still had the advantage. One strong reason for this, we may well believe, was a general feeling that close coupling would diminish the maximum load which could be hauled by locomotives, since it would compel them to start the whole train at once, instead of car by car. The writer of this article was one of those who strongly held to this opinion, as he thought on strong technical grounds, and it was at his suggestion that the tests were made at Burlington of the comparative starting power of locomotives with and without slack. These tests showed most conclusively that there was no real difference in this respect; while it is a matter of common knowledge, which no mechanical engineer will question, that the existence of loose slack in the train does greatly aggravate the danger of breakaways.

Since then, in the face of much and steady opposition, there has been a steady and notable increase in the number of adherents to the M. C. B. type, until it has become, as our correspondent correctly states, a "popular movement." At no time has the movement gone backward. No single company has adopted the M. C. B. type on any considerable scale, and then abandoned it; but one by one additional companies have fallen into line, until we have the really startling exhibit of progress shown on our map,—an exhibit, by the way, in which the 650 cars on the D. & H. C. Company's Railway to which our correspondent refers, did not figure at all; so that we judge they must be a very recent addition.

Now, to what proportions has this movement at last attained? We do not propose to rehearse all the figures given in our issue of Dec. 21, which for the first time revealed the real strength of the movement, but will merely repeat a few facts from it: four companies alone, after some years of experience each, have now 25,000 cars equipped; there were less than 6,000 cars in all equipped at the beginning of 1888; there were 15,000 added in 1888, so that there were 21,000 equipped at the beginning of 1889; there were at least 39,000 added in 1889, so that there were at least 60,000 equipped at the beginning of 1890; "the error in the above estimates," as we said in our former article, "being almost certainly a too small allowance for 1889, as necessarily many orders in the latter part of the year were not reported to us." One of such orders, and one of some importance, we now first hear of through our correspondent. The increase in the number of companies using M. C. B. couplers has been even greater in proportion than the increase in number of cars equipped. We will not stop to count them up.

Now from what else can this great advance have come than from the "honest opinion based upon practical experience," which our correspondent justly says, "is surely worthy of respectful recognition," but which is surely as worthy of it from those who oppose the M. C. B. type as from those who favor it? Our correspondent suggests that "numerical statements or graphic charts" showing it, "prove, not the excellence of the M. C. B. coupler, but the activity and business ability if manufacturers;" but quite as much "activity and business ability" has been enlisted in favor of the link type in the past ten years as in favor of the M. C. B. type, and it is paying a very left-handed compliment to, and making, we believe, a most unjust charge against, some dozens of high mechanical officials, to say that they are being passively led by manufacturers into introducing such costly (if bad) appliances.

Neither will the fact that the type has been standardized explain the recent rapid progress. This, like all other M. C. B. standards, stands purely on its merits. The M. C. B. Association treats its standards much as an ostrich treats its eggs,—leaves them to take care of themselves, and does not even make inquiries as to their later fate. It is a notorious fact that numbers of these standards have been and are almost wholly neglected; and fully half of them (if we may hazard the guess) could not make so good a graphic showing as the coupler does, although of much longer standing.

There is but one rational conclusion to make from all the facts in this case, it seems to us, that SOLID MERIT is pushing the M. C. B. coupler to the front. We freely admit that coal service is about the hardest to which a coupler can be subjected, and in that respect the service of the distinctively coal roads is somewhat peculiar to itself; yet after all, this difference is mainly because the average coal train has such an immense amount of loose slack in it as to make it especially hard on a more mechanical type of coupler during the transition period. The plain truth of the matter is that the handling of coal trains has been and is inexcusably careless and rough, and in great part because of habits engendered from the very existence of the loose slack which it is one object of the M. C. B. type to do away with.

With this proviso, however, we must dissent from our correspondent's conclusion that "already the numerous breakages *show conclusively* (italics ours) that the adoption of the M. C. B. type would prove a costly luxury *for this company*." If they show it conclusively for his company, they show it conclusively for all companies. It is absurd to claim that any coupler which is "shown conclusively" to be too weak for coal service is really fit for any freight service whatsoever. Any freight car may be exposed to the same usage as a coal car; the two are coupled together constantly in the same trains, and probably Mr. BLACKALL would not claim that his road was in the habit of using *all* freight cars so much more roughly than do other roads that a coupler which was found to answer very well on other roads would not answer on his. But if his breakages are running up to such fearful aggregates as he implies, it must be that his trainmen do treat cars more roughly than others, or that he has made an unfortunate selection among the M. C. B. couplers; for the evidence is ample that many roads who have been experimenting with the type for many years find their experience to be most encouraging.

As to our correspondent's claim: "It is a *notorious fact* (italics ours) that many of the most pronounced advocates of the M. C. B. type are already weakening in their allegiance, and frankly confess that they were too hasty," we must confess that this is news to us. We had understood the notorious fact to be the direct reverse of this; and we shall be greatly obliged to any one who will give us the name of one such "pronounced advocate" (supposed to be also a man whose position entitles his opinion to weight) who has thus "weakened," as we do not know of one. We do know that various people have had trouble with particular couplers, but not, to our knowledge, such serious trouble as to lead them to condemn the type, after once advocating it.

Finally, as to whether the M. C. B. type is "strictly automatic," it is unnecessary to "ask any trainman"; the facts speak for themselves. In the ordinary meaning of that term, it is strictly automatic. It is admittedly sometimes necessary to go between the cars to set the knuckles, *but not in the act of coupling*. The Marks coupler, and several others of the link type, are undoubtedly of much merit; but that is not to the purpose. In this detail, of all others in railway practice, UNIFORMITY is the great desideratum. The question is not: Is the Marks coupler a good one? nor even, Is it the best one for special service? but rather, Is it an attainable one, and also the best one for universal use? If our correspondent believes this, he is right in being "stubborn," for stubbornness is an honorable quality in a good cause. But let every man be first sure that it is a good cause, and that he is giving due weight to other men's experience and convictions as well as to his own. It is undoubtedly true, as our correspondent says, that many mechanical novelties which have started in with great success have finally died out, and up to a certain point every man is justified in witholding his judgment; yet as a rule "revolutions do not go backward;" and we recall no previous mechanical movement that, after having attained such standing as our map of brake and coupler introduction revealed, has finally gone backward. To show to just what proportions the movement had attained was one purpose of our map. We hoped and expected that it would do much to crystallize practice, but hardly expected it to show that practice had practically already crystallized.

THE ATLANTIC COAST LINE RAILWAY SYSTEM should be shown in a full green line as well as a full red line on our map of Dec. 21, General Manager WALTERS writes us, as the Westinghouse brake has now been applied to a number of freight cars greater than half the number of miles operated.

CORRESPONDENCE.

M. C. B. and Other Automatic Couplers.

Del. & Hud. Canal Co. N. R. R. Dept.,
Office Supt. Machinery.

ALBANY, N. Y., Dec. 30, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

SIR,—I notice an article in ENGINEERING NEWS of Dec. 21, on "Progress in the Use of Automatic Car Couplers" in which you say: "The roads which still cling to the automatic link type, with a stubbornness worthy of a better cause, are most of them of local importance merely."

I thank you for the compliment. Among the roads, however, so ruthlessly consigned to oblivion will be found many whose continued use of another type of coupler than that prescribed by the M. C. B. is based upon something quite different from "stubbornness," as you are pleased to call it. Honest opinion based upon practical experience, and a knowledge of the inherent defects of the type you champion, is surely worthy of respectful recognition.

In the case of the company I represent, for your fuller information, I wish to state that we have 250 cars equipped with the M. C. B. type of coupler, and 400 are under contract on which the same coupler will be placed. We have not, therefore, been so "stubborn" as to ignore the popular movement in favor of the Vertical Plane type, and are carefully watching the performance of these couplers in service on our own line, in comparison with the type of Automatic Link coupler so successfully used by us on our coal equipment. Already the numerous breakages show conclusively that the adoption of the M. C. B. type would prove a costly luxury for this company.

The large coal roads, with their extensive equipment, may well hesitate before they commit themselves to a coupler so open to criticism as the one under discussion. It is a notorious fact that many of the most pronounced advocates of the Vertical Plane type are already weakening in their allegiance, and frankly confess that they were too hasty in concluding that the problem had been solved for all time when the M. C. B. Association declared in favor of this principle in coupling cars. They are not deceived by numerical statements or graphic maps, proving, not the excellence of the M. C. B. coupler, but the activity and business ability of manufacturers.

Every practical railroad man knows that costly mistakes have been made in the past in equipping roads with devices which afterwards proved worthless for the purpose intended. History often repeats itself. Half of the railroad equipment of the United States may be fitted with the M. C. B. type of coupler, but, if the record of breakages, cost of maintenance, injured or maimed trainmen, remains practically the same as before, like everything else that has had its day, it must go. Much has been said and written of this coupler from a humanitarian point of view. Ask the trainmen whether this type of coupler is strictly automatic! It will not couple without going between the cars, as the knuckle must be open before coupling; if the knuckle opens by gravity, a person must go between the cars to close it before it can be coupled to the ordinary draw-head. It is well known that the trainmen are constantly injured in this manner. It will not do to assume, as many have done, that this is necessary with all types of automatic couplers. An examination of the Marks coupler, which is of the Automatic Link type spoken of so contemptuously, will prove conclusively that it is never necessary to go between the cars either to couple or uncouple. We have 2,450 cars equipped with this coupler, and can, therefore, speak positively as to its merits as a safety appliance. It is certainly not from "ignorance or apathy" that this company has declined to forsake an automatic coupler combining in a marked degree safety, economy, positive action, simplicity and strength, for one not yet perfected.

We are in accord with your views as to the desirability of the universal adoption of air brakes for freight trains. It cannot come too soon. From data kept of freight car movements over our line, we find that over 12 per cent. are equipped with air brakes.

Respectfully yours, R. C. BLACKALL,
Supt. Mach'y.

["Stubborn," as defined by WORCESTER, means simply "persisting, persevering, steady," and the charge of "stubbornness," therefore, neither means nor implies any more than that those who still refuse to accept the M. C. B. type of coupler are refusing to join in a movement which is becoming so general that not to join it makes one an exception. That this is the case, the maps and tables to which our correspondent refers clearly show. Moreover, we only said that "most" of the roads which still cling to the link type were of "local importance only." We freely admit that the D. & H. C. Co. is a road of more than local importance, but then, the D. & H. C. Co. is almost if not quite the most important line on the whole continent which refuses to accept the M. C. B. type while yet doing anything to introduce automatic couplers of any kind.

So much for the personal question. On the other general questions raised in the letter as to "M. C. B. and Other Automatic Couplers," we have something to say in another column; and we will only add here that, out of a large mass of correspondence which has reached us, this is the first letter which has made any serious attack on the M. C. B. type on its merits.—ED. ENG. NEWS.]

Cornell for the Next Convention of the American Society of Civil Engineers.

Cornell University, College of Civil Engineering,
ITHACA, N. Y., Dec. 20, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

I have been asked by several members of the American Society of Civil Engineers to make public through your columns the reason for desiring that the next convention of the Society should be held at Cornell University.

The strongest reason I have to urge is that this University has the largest plant to be found in the world for the education of the civil and mechanical engineer, the architect, and the electrician. Charlottenburg, near Berlin, may perhaps have a larger total scientific plant; but its equipment is used more as a museum of illustrative material than as a laboratory for individual experimentation; nor are its facilities at the absolute free disposal of students for private research or required or voluntary study; neither are the subdivisions of groups of the German laboratories broken up into well-defined and complete appliances for the study of specialties by students, graduates, or professional men designing to investigate definite problems in an adequate scale, from the engineer's standpoint of research. The famous laboratories of Zurich and Munich are comparatively small, and are not laboratories where students are brought face to face with nature, taught to control its forces and to reconcile the differences between theory and practice with the rational discretion demanded in a profession like ours, which contains as many elements of business common sense as of science. These laboratories refer to specialties of teachers who are themselves professional men, and for the most part are engaged in private investigation for private gain.

Cornell has also recognized the barrenness of results produced by such technical schools as are now being smothered in the atmosphere of colleges governed by the so-called academic faculties, which are but too often devoid of scientific instincts or sympathies, and are usually controlled by a narrow, hair-splitting president or professor of moral philosophy, who has an honest contempt for science in general and technical science in particular. For these reasons the technical courses of Cornell University, as well as the general, academic or literary, and philosophical courses, have been surrounded, each with the atmosphere and system of administration best for its unrestricted growth. Cornell has also placed officially all its courses on the same mental and social rank. The students of agriculture and the students of philology walk arm in arm over our campus subject to the beneficent influence of ingenuous tolerance (not a small educational force by itself).

It seems to me that the peculiar features of Cornell should interest our colleagues in the American Society of Civil Engineers, and justify a visit to the seat of the new education. Much may be said and gained by such a visit that would strengthen the excellent schools of engineering we have already in the country. Such a visit would contribute not a little toward taking active steps looking to the elevation of our profession to the legitimate height that it has not yet attained. It is certain at least that we are far behind the French engineers in professional standing, even though their responsibilities are less fraught with professional danger to the individual, and their training and their advancement are far less difficult than is the case with the American engineer.

As to minor points, I may add that the University town is accustomed to entertain our large Commencement crowds, and can offer reasonable and excellent accommodations.

The surroundings of this locality are superbly beautiful. Short, pleasurable excursions may be made to points of professional interest at Athens, Rochester, Syracuse, Elmira, etc., and on Cayuga Lake, a summer resort of exquisite beauty. The University, I am sure, will offer its shelter to the convention in sumptuous buildings, with every convenience for its general sessions, offices, and committee rooms. The University is accessible by main lines of railway from all quarters of the compass. Members not wishing to join the excursions may remain in the University grounds, and spend at leisure several days inspecting our libraries, laboratories general museums, and the greenhouses, foundries, workshops, special museums, of technology, laboratories of Civil and Mechanical Engineering, Architecture, Agriculture, etc., collections of art, and literary and archæological treasures.

I may also add that it will be a pleasure for me to welcome here old friends and my professional colleagues; and I may bespeak a hearty welcome from the members residing here as well as from the University and the city, who will appreciate the honor of having in their midst so distinguished a body of engineers.

Very respectfully,
E. A. FUERTES, *M. Am. Soc. C. E.*

[There can be no doubt, it seems to us, that Cornell would be in many respects a most admirable point for holding the convention. The great difficulty is, however, the lack of adequate hotel accommodation. Experience seems to indicate that one of the most useful features of these conventions is lost when the members are not all together out of the convention hours, which can only be in a hotel large enough to hold them all.—ED. ENG. NEWS.]

Six-Place Logarithmic Tables.

ALBANY, N. Y., Dec. 23, 1889.

TO THE EDITOR OF ENGINEERING NEWS:—

I write to enter a mild protest against your condemnation of 6-place logarithmic tables.

In the manner in which they are generally served up for a long-suffering race of engineers and engineering students, they may well nauseate, but the writer believes that the engineer never need use the 7-place tables if he has the *more convenient* (Italics ours.—ED.) 6-place. All that you say in respect to the 4-place and 5 place tables is heartily agreed to, but the engineer may occasionally have to compute a carefully measured triangulation or to prepare numerical tables where a little further precision is desirable.

Unless the angles of a triangulation have been measured with a certainty beyond tenths of seconds (and what engineer has ever so measured angles?) six-place tables are more in accord with the precision of the angular measurements than 7-place would be.

Let the engineer add to his library the tenth edition of BREMIKER'S 6-place table, Berlin, 1886, price 4.20 marks, if he desires a most convenient book, fully sufficing for the occasional precise computations needed in his work. This tenth edition is in every way as complete as VEGA'S 7-place tables, which it much resembles, while the interpolation, as might be expected, is easier.

The writer believes a detached book of tables to be more convenient than one fastened to the end of a text-book, and he has found none equal to GAUSS'S 5-place tables, which, having been through some 20 editions, can be used with confidence as to their numerical accuracy. Would it not be well for Mr. WELLINGTON, in his new manual, to photographically reproduce such tables as GAUSS'S, and thus insure accuracy and secure all the merits of this excellent work? The great Thesaurus of Vega has been thus reproduced in Florence, and can now be purchased for 5 francs. This reproduction is beyond question a faithful one, but the original has been improved upon, as the known typographical errors are corrected in the reproduction.

It would seem that the 7-place tables may indeed be the ones that eventually will be found to occupy no useful place. They do not fully satisfy the worker in geodesy, and a much needed 8-place table is now being prepared by the French Government, from a manuscript 14-place table in the library of the Paris Observatory, to serve his purposes, while the 6-place tables are quite sufficient for almost every purpose where 8 places are not wanted.

HORACE ANDREWS.

[Our correspondent advances views which we think have no warrant in the practical work of professional computers, who, to the best of our knowledge and belief, confine themselves almost wholly to 5-place and 7-place logarithms, the 7-place being vastly easier to use than the ordinary 6-place table, for the reason that it extends to 100,000 instead of 10,000. For this reason we have used the 7-place tables extensively even for 5-place work, all trouble with differences being thus saved. We have never seen the Bremiker 6-place table mentioned, which extends to 100,000, but cannot but think it a very foolish kind of table, as it has all the inconvenience from bulk of the 7-place table with but one-tenth of the accuracy. That there has been but one edition each of 6-place and 8-place tables to 100,000 while there have been dozens of 7-place, shows what computers think about the matter. We have not been referring to a 100,000 6-place table in what we have said about them, however, but only to the ordinary 10,000 6-place tables; our position being that in a 10,000 table five places are as many as can be used to any advantage, and that when the table is expanded to 100,000, which means, converted into a

bulky volume, the added accuracy of the seventh place can be and should be had. The 5-place log. of 100.00 being 2,00000 and the log. of 100,002 being 2,00001, what greater accuracy is needed for ordinary field work? When we pass from this to geodetic and astronomical work, a hundred times this accuracy is none too great. In the angular functions the case is even stronger; the 5-place sines for 45° differing by 12 to 13 units for each minute, which permits of quite as fine computation as the best field instruments can warrant.

The advantage of the 5-place and 7-place tables is that there is just comfortable room at the side for the convenient 1-to-9 side difference tables which make interpolation so easy, but are wholly lacking in the common 6-place table. Such a table to 100,000 can have these conveniently, but no more conveniently than the 7-place, while only one-tenth as accurate. The *reductio ad absurdum* of the 6-place table may be seen in SEARLE'S field-book, where the differences at the bottom of the page are nearly as bulky as the table itself, making it exceedingly awkward to use, as any one will find on trial.

As for photographically reproducing the Gauss tables, Mr. WELLINGTON hopes to effect some slight improvement in their typographical form and arrangemeut, while making them, and the Vega tables for the most part, a model; and as he has made arrangements to have each table read through three times at least without detection of error before it is passed as correct, which is as great a precaution as was used with the Bremiker tables, he believes there will be no difficulty in insuring absolute correctness.—ED. ENG. NEWS.]

Formulæ vs Formulas.

LONDON, ENG., Dec. 19, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

I entirely agree with your comment on Mr. JAMESON'S letter in ENGINEERING NEWS of Dec. 7, and think the reasons you give in favor of the ordinary English plural, formulas, are unanswerable. A story is told of an experienced English judge who evidently held the same view. During his summing up of a case he frequently made use of the word memorandums. A pert young counsel took upon himself to correct him: "Surely, m' lud, the plural of memorandum is memoranda." "Oh, certainly," replied the judge, "if it's better English."

I notice that in the Preceedings of the Institution of Civil Engineers, the word is now invariably rendered as formulas, also "Mr." is now given, instead of M., Herr, etc.

Yours respectfully,

F. G. D.

Notes and Queries.

W. B. H. asks: Would you kindly send me the rise, per 100 ft., in some of the inclined planes in use in the United States, where standard gauge cars are in use? I have been unable to find any satisfactory information in regard to them in any work that I have access to.

About all the available information on this head our correspondent will find in Mr. WELLINGTON'S "Economic Theory of the Location of Railways," if he refers to planes operated by ordinary locomotives. If he refers to inclined planes operated by cables or other special power, the steepest is on the Mt. Washington Railway, within a few miles of him, and any rate is practicable, up to the vertical rate of elevators.

A correspondent writes us:

I presume railway engineers have had a similar experience to the following, (if an anecdote is in order); After putting tacks in a number of hubs for transit points, they being close together, work was postponed until next day, when, to the rage and disgust of the whole party, the tacks were "found missing." No one knew or could think where they had gone until the leveler, remembering the Italian idea of how to make boot-soles wear well, agreed to find the missing tacks. He went to each Italian working in the construction gang which had just begun work the day before, lifted each foot in turn and inspected them carefully. Before we fairly understood what he was after, a vigorous application of the leveler's boot surprised both us and the Italian. The tacks had been found!

PERSONAL.

Mr. G. A. BELL has been appointed General Superintendent of the Troy Steel & Iron Co., Troy, N. Y.

Mr. CHARLES F. MAYER has been reelected President of the Baltimore & Ohio R. R. Co, by the Board of Directors at their annual meeting.

Col. W. A. BANCROFT, of Cambridge, Mass., has resigned the position of Roadmaster of the West End St. Ry. Co.

Mr. J. N. METHEANY, Superintendent of the northern division of the Grand Rapids & Indiana R. R. died recently at his home at Grand Rapids, Mich.

Mr. D. E. THOMPSON, Superintendent of the Burlington & Missouri River Railroad in Nebraska, will resign shortly.

Mr. JAMES MALONE, a retired railway contractor, died at Marietta, Pa., Dec. 19. He built some sections of the Northern Central R. R.

Mr. J. A. L. WADDELL, M.Am. Soc. C. E., is Chief Engineer of the new Sioux City bridge over the Missouri for the Pacific Short Line Ry.

Mr. HENRY D. WALLER, who was Superintendent of the Pittsburg, Fort Wayne & Chicago Ry. some years ago, died in New York Dec. 24.

Mr. R. L. TAYLOR has been elected Vice-President of the Tennessee Midland Ry. Co. vice Mr. T. C. LEAKE, Jr., resigned.

S. B. MCKEE, C. E., has been appointed Engineer-in-charge of the construction of coal piers and trestles at Weehawken, N. J., and Oswego, N. Y., with headquarters at Middletown, N. Y.

Mr. JOHN HEDDING, formerly Superintendent of the Rogers Locomotive Works, at Paterson, N. J., and Master Mechanic of the New Jersey R. R. & Transportation Co., has been appointed Superintendent of the King Locomotive & Car Works at Bordentown, N. J.

Prof. J. W. SPENCER, Professor of Geology at the State University, Athens, Ga., has been appointed State Geologist of Georgia. The State is divided into three sections, and the State Geologist and his assistants will preside each over a section.

Mr. CHARLES SOOYSMITH was elected, on Dec. 17, a director of the Hudson River Tunnel Co., in the place of Mr. O. A. GANGER, deceased. As now constituted the Board consists of H. W. PERKINS, W. M. FORCE, A. B. GIBBS, H. S. WHITE, F. P. ABBOT, C. E. WELLING, and C. SOOYSMITH.

N. S. KROUGLICOFF and A. B. J. KONDZATOVITCH, Russian civil engineers, are on their way to New York from Japan, via the Canadian Pacific Railway. They have been sent by the Russian Government to inspect American railways in view of the proposed building of the Siberian railway. They were in Ottawa on Dec. 27, and will visit New York and Philadelphia.

HORATIO ALLEN, who ran in middle life the first locomotive which ever turned its wheels on this continent, and who has been a prominent engineer almost since engineering began on it, died at Orange, N. J., on New Year's morning in the 88th year of his age. We shall next week more adequately and fully notice his death.

Official circulars have been issued announcing new appointments on the Missouri and Mountain Divisions of the Union Pacific Ry.: Mr. C. F. RESSEGUIE is to succeed Mr. G. M. CUMMINGS as General Manager of the Mountain Division; Mr. JOSEPH M. BARR, Superintendent of the Cheyenne Division, takes the place here made vacant by Mr. RESSEGUIE'S promotion; Mr. B. M. RYDER succeeds Mr. BARR, and Mr. R. M. BAXTER becomes Assistant Superintendent of the Wyoming division.

Mr. CHARLES A. ASHBURNER, formerly Assistan State Geologist of Pennsylvania, died Dec. 25. While an undergraduate at the University of Pennsylvania he was one of a party who made a survey of the Delaware River. He was graduated from the university as a civil engineer in 1874, standing first in his class. He immediately started on his professional career, first in the Light House Survey Service, and soon advancing to an important position in the Geological Survey of Pennsylvania While at college he had won the esteem of Prof. J. P. LESLEY, who was made State Geologist in 1874 at the time of the organization of the second Geological Survey of Pennsylvania; Mr. LESLEY appointed Mr. ASHBURNER one of his assistants, his duties being confined at first to the surveys of Juniata and Mifflin counties. In 1875 he was appointed Assistant State Geologist in charge of the surveys in McKean, Elk, Forest and Cameron counties. In 1880 he was placed in charge of the surveys of the anthracite coal fields. He published in 1884 his Report on the Anthracite Fields of Pennsylvania, now an acknowledged authority on this subject. As a reward of merit for this report, the University of Pennsylvania conferred upon him the degree of Doctor of Science. His ability and skill being recognized, he was appointed in 1885 Assistant State Geologist, in charge of all the office and field work of the Survey. He resigned his position with the State in the autumn of 1886, and was connected during the year 1887 with the Fuel, Gas & Electric Engineering Co, of Pittsburg. During the past year he has been closely associated with the Westinghouse interests and has devoted his time largely to expert work. Only a few months since he, together with Mr. GEORGE WESTINGHOUSE, organized the Duquesne Copper Co., of which he was Vice-President and General Manager, to develop mines in Arizona.

The Use of Dynamite at the Johnstown Drift Dam.

At the last meeting of the Engineers' Society of Western Pennsylvania, Mr. ARTHUR KIRK read a paper with the above title, describing in much detail the nature of the drift deposited against the Pennsylvania Railroad bridge at Johnstown, Pa., and the methods adopted for removing it. The following is an abstract:

The author was on the ground immediately after the terrible flood, and describes the general local conditions which brought about the jam much as they were described in this journal at the time. He later measured the mass at the bridge, and found it to be 350 ft. wide, extending about 800 ft. up stream and apparently 20 ft. deep on the average, with many places 40 ft. deep. This jam was made up of almost every conceivable species of wreck, houses, furniture, trees, railway bridges and track, all consolidated by thousands of tons of brick, sand, plaster, gravel, etc., and interwoven with hundreds of miles of telegraph, telephone, and other wire. The flood traversed eleven miles of valley, covered with almost unbroken forest, before reaching the bridge, and these trees, laurels, and bushes were torn out and tangled with the other wreck in one bewildering heap of rubbish. Mingled with this debris there were at the time from 3,000 to 5,000 human being and in it thousands met their death.

MR. KIRK was one of the engineers detailed to superintend the removal of this drift jam. He commenced with dynamite in 5-lb. charges, and increased the load to 10 lbs. whenever this could be done without injury to the stone railway bridge. Electricity was used in firing, and as many as 24 ½-lb. cartridges were fastened to a board by twine and nails, and this board then pushed 6 or 10 ft. below the water alongside of a heavy log and in groups 10 to 20 ft. apart, and exploded. The effect was to cut the log into segments and throw these into the air, and in so doing shake up a large area.

So-called "sausage torpedos" were made by slipping 20 cartridges into 2-in. water-tight tubing and then firing them with an exploder put into each end cartridge. This torpedo was used in cutting through the floors of railway cars, etc. Bag-torpedos, loaded with 80 cartridges and lowered by a pole through the water, were also effectively used. At other times, the usual 50-lb. box, in which the dynamite came, was used to hold 35 lbs. of the explosive, held in place by sand and lowered by a rope to the desired point of attack.

Logs were cut off and stumps removed by boring 1¼ in. holes 10 in. deep and loading with ½-lb. cartridges. By using a large number of holes, the heaviest logs were thus cut into kindling wood size and floated off. The largest single blast fired consisted of 450 lbs. in nine boxes placed from 25 to 35 ft. apart in three rows of three boxes each. The result was that about an acre of the drift was broken loose and floated away. The dynamite used was commercially equivalent to 75 per cent.

THE STATE FORESTRY COMMISSION of New York will present to the Legislature a bill which will be an amendment to the railway laws, making it illegal for any railway company to secure the right to condemn or acquire in any way any of the State forest lands for the extension of its line. The Commissioners expect to have considerable difficulty with the railways because of this measure. The bill calling for the right of the Commissioners to try cases for violations of the forestry laws in any country in the Forest Preserve has already been thoroughly discussed, yet it is one of the additions to the existing laws which are considered to be absolutely necessary. Another bill is to empower the Commission to purchase large tracts of land about the head waters of the various great rivers of the State, and asks that a considerable sum of money be set aside for this purpose. These measures are of considerable importance, especially the first and third mentioned, for the preservation of the forests.

The Effect of Acting on Good Advice.

Our lively friend, Mr. B. U. STED, represented in the flesh by Mr. F. S. INGOLDSBY, sends us the following gratifying cartoon showing the effect of acting on the advice which we took the liberty of tendering him a year ago, on receipt of a similar but much less cheerful cartoon, embodying a pathetic appeal of Mr. STED's to N. O. WORK, Esq., Chief Engineer, for "any kind of a job." The first of this series of cartoons from Mr. INGOLDSBY was sent us on Christmas, 1887, and was engraved for our first issue of 1888. The visionary figure in the background over "1887" will recall it to our reader's memory. The second one was not engraved, for reasons stated in our issue of December 29, 1888, in connection with what was then and is still the best advice we knew how to offer to Mr. B. U. STED, and which we therefore reprint in full below, both to explain the cartoon and to let who will profit by it, as Mr. STED has evidently done; adding only this further word, that our modesty will not permit us to ascribe Mr. STED's gratifying progress, from the exposures of 1887, through the dumps of 1888, to the glorious consummation of 1889, wholly to the excellent effect of our advice, but we must ascribe it in part at least to the beneficent effect of continuous perusal of ENGINEERING NEWS on his professional capacities! Here follows, at any rate, the advice we reprinted as an appropriate accompaniment to graphic evidence of alleged effect of acting on it in one instance. And we will say in all seriousness to young engineers, knowing from experience the disappointments which come to so many of them, and heartily wishing them well, that this lively caricature hardly exaggerates the effect which continuous acting on the spirit of the advice tendered will have upon their fortunes, not in one year, nor in two years, probably, but in the end. Our genial friend, Mr. WILKINS MICAWBER, once remarked: "Income, £1, expenses, 19s. 3d., result, happiness. Income, £1, expenses, £1 1s. 1d.; result, misery." On the same principle we may say, with equal truth: "Value of average man's services (depending chiefly on the two great factors, industry and fidelity) 100, value of STED's services, 100.1; result, success: value of STED's services, 99.9; result, disappointment." On such slight causes do very great effects depend; and it therefore lies in the power of every man, not an incurable blockhead, to make a satisfactory future for himself. He can hardly make himself "on Fortune's cap the very button," unless he have great natural abilities as well, yet genius itself has been defined by a high authority as merely "an infinite capacity for taking pains," and any man can at least take pains if he will, and will find the capacity to do so grow by exercise. But we will not further repeat our last year's remarks on this subject, which we have started to republish, and which were as follows:

The Effect of Acting on Good Advice.

A correspondent, Mr. F. S. INGOLDSBY, sends us a rather dismal "Christmas G eeting" whose artistic merit hardly warrants reproduction, since it consists simply of an open letter lying over a box labeled "File 908. Applications" and bearing this pathetic appeal:

UPSTUMPS, Dec. 25, 1889.

N. O. WORK, ESQ.,
Chief Engineer.

DEAR SIR:

I hereby respectfully apply to you for a position.

I have been in charge of both location and construction for the past ten years, but will gladly take anything from rodman up.

Will be pleased to show you endorsements from every prominent engineer in America.

Respectfully,
B. U. STED.

We reproduce the letter as in a sense at least seasonable and appropriate, and as giving a bit of personal news about a gentleman who has been well known to almost the entire profession at some time or other, and one in whom they all feel a deep personal interest, Mr. B. U. STED. No doubt his countenance has become particularly familiar to a great many during the past year, as there has been this year a very decided falling off in engineering activity from last year's conditions; nor do we yet see signs of any great revival this year; or at least not such a one as will do Mr. B. U. STED much good, for as a rule what he requires to make him thoroughly happy is something more than a fair average year,—a regular "boom" year, in which one hardly needs even to open his mouth to have some plum fall right into it. Such a year was 1887, such a year was not 1888, and such a year 1889 will hardly be. Unless all signs fail, however, 1889, like 1888, will be a fair average year, which is the kind that all engineers should pray for; and if Mr. B. U. STED continues much longer in his dismal plight, we think he should carefully go over his mental machinery and see what screw is loose about it, for probably in that screw lies his trouble. At any rate, we make public Mr. B. U. STED's appeal, and we earnestly hope that all those who know him (and who does not?) will try to see if they cannot celebrate this festive season by giving him what he asks for.

We have not ourselves, at this moment, any position at our disposal which would answer Mr. B. U. STED's requirements; but we knew him so long and intimately in the cheerful days of '73, and came to feel such pity, if not affection, for him, that we are loth to pass him by altogether at this merry Christmas season, and have concluded, as is becoming the season, to at least give him—a little advice.

Mr. STED is too general in his application. A man who simply asks for "any" position generally gets one of the kind described by the poet: "They also serve who only *stand and wait*." His very letter is his own condemnation, and leads us to think he has neglected his opportunities. He has been at work for ten years as leveler and transitman; is he not yet fitted for something higher instead of lower? There are, to be sure, many excellent men who are temporarily disengaged, even in the best of times; and the sensible among such do not stand waiting long for just the position they want, but take the first they can get. In that respect the spirit of Mr. STED's letter is good, and worthy of imitation; but a man who has just lived through the boom period of 1886-7 after seven or eight years experience as transitman, etc., and who has not at any time during it been invited to step up higher, may justly be feared (especially when the only evidence to the contrary is such a letter as the above) to lack the qualities which command success, the chief of which is a habit of incessant study of the duties of the grade next above him, and (what is the same thing in effect) of incessant effort to do the work which is given him to do a little better than any one else does it. *Fidelity* is the card of cards for Mr. STED to play, and if he plays it, it will probably not again happen to him, as it plainly did last year, that his will be the first head hit by the "reduction of force." On the contrary, he will be the one with that *slight* shade of difference in his favor which is alone needed to make him the last instead of the first to go. If average industry (for industry is a much more important factor than abstract capability) be represented by 1.0, the man whose industry = 1.1 goes ahead like a shot, while the man whose industry = 0.9 only, drops out. We do not forget that mean and shabby personal motives often have much to do with such choice, and that it is often the best engineer who gets "left," but even then, although there are often abominable cases of pure favoritism, in Mr. STED's case, they are much less frequent than he imagines, originating for the most part in another defect of his which is almost if not quite as bad as a lack of knowledge—a lack of tact. Mr. STED should engrave upon the tablets of his heart these words, by the greatest of modern philosophers. He will find they will help him:

"What matters thy knowledge,
What boots it thy parts,
If one thing thou lackest,
The art of all arts.

"The key to all fortune,
Passport of success,
Opens office and parlor,—
Address, man, *address*."

Again, Mr. STED is, we fear, too fond of writing letters to those whom he does not know, asking for anything, instead of presenting himself in person to those he does know and demanding something—and taking it: if it be only the privilege of working for nothing until something better turns up. In "boom" years positions are often secured simply through written applications, but not often at other times, for the reason that even the best worded letter is no positive evidence of the character of the man, and positive knowledge of fair capacity counts for much more than the possibility of much more capacity—and the possibility of less; and "makes us rather bear those ills we have than fly to others that we know not of." It is a much better plan generally to trust to personal application, making the "grand tour" if necessary. We must not be thought to be "seeking business" when we say that a brief card in our "want" column is more likely to be effective than letter-writing; but much better than that again it is for the engineer out of work to first see all he can where he lives, and write to those who know him personally, and then burn his ships behind him, and start out with the determination to get something to do, if it be only to work for no pay at all. It is a hard and disagreeable position, we know that; but young engineers may remember for their comfort that it is not half so hard as the position of young doctors and lawyers, who cannot even apply for work, and who for the first ten years of their professional life almost invariably average a far smaller income than young engineers.

Irrigation in Idaho.

The report of Gov. GEORGE L. SHOUP, of Idaho, to the Secretary of the Interior contains matter of interest on irrigation possibilities and progress in that Territory.

The first part of this report is historical and statistical, but it may not be out of place here to abstract some of this history and statistics as follows: Idaho was a created a Territory by act of Congress, March 3, 1863, out of parts of Dakota, Nebraska, and Washington Territories. It originally contained about 325,000 sq. miles of area; but by an act of May 25, 1868, it was finally reduced to 86,294 sq. miles, having a length from north to south of about 410 miles and a width varying from 44 to 306½ miles. The total population in 1889 is 113,777 as near as can be ascertained. The total valuation of property for 1889 was $23,948,039, with an assessment roll of fully $25,000,000, due later additions. The area of the Territory, from careful estimates, is divided as follows:

	Acres.
Agricultural lands	16,000,000
Forest lands	10,000,000
Grazing and mineral lands	20,000,000
Rough, unfit for cultivation	8,000,000
Lakes and rivers	1,228,160
Total	55,228,160

Of this area 8,500,000 acres have been surveyed, and over half of this entered or filed under the several land acts. A detail follows of the resources and valuation of each county of the Territory separately, which is valuable and interesting, but out of place here.

In regard to irrigation, the report says that the application of water to the arid lands of the Territory has demonstrated beyond question the great productiveness of the soil. The question is, how to convey and apply this water; and prompt and decisive action looking toward the control of this water should at once be taken. In connection with the proposed action of the Government in regard to the surveys for irrigation reservoirs, Mr. JOSEPH B. STRAUGHAN, Surveyor General for Idaho, had maps made for each county having within it irrigable lands. These maps, and the detailed reports accompanying each, show the area of the county, the area irrigated and irrigable, the length of canals built and proposed, and the sources of the water supply.

A recapitulation of these data, as given for each county, shows a total as follows:

Approximate area considered	56,174	sq. miles.
Irrigated and in progress	740,350	acres.
Irrigable, as reported	8,051,000	"
Land now irrigated	9.2	per cent.
Total area reclaimable	24.0	" "

The return by counties, as near as it can be figured out, shows nearly 2,400 miles of canals and ditches of all kinds and sizes as now in use in the Territory.

An interesting meteorological report is also issued as compiled from the records of the United States Signal Office at Boise City. This table covers the years 1878-1889, and gives the data for each month separately; but as this table is not summarized, it is hardly useful to attempt extracts.

AN EIFFEL TOWER OF ICE is to be constructed at Montreal for the winter carnival, instead of the usual ice palace. It will be 266 ft. high, and illuminated by the electric light, while fireworks will be discharged from the second platform every evening. So says a Canadian exchange.

Scientific Progress in 1889.

Considerable progress has been made during the year in photographing certain nebulæ and other star clusters. Photography has also brought to light many very faint (gaseous) nebulæ which the telescope fails to detect. The moon's surface has also been photographed and its minutest details brought out with a distinctness hitherto unknown.

The 1,475 photographs of the transit of Venus for 1882, taken by the American astronomers at Washington and elsewhere, have been reduced, and the solar parallax resulting therefrom is 82 in. .847, which corresponds to a mean distance of the earth from the sun of 92,385,000 miles, with a probable error of only 125,000 miles. These numbers are no doubt close approximations to the truth, but they cannot be regarded as final until all the observations made by astronomers in other countries are reduced and discussed. From the known values of precession, aberration, nutation and all the other factors which can in any way enter into the solar parallax, Prof. HARKNESS, of the Naval Observatory at Washington, has, on theoretical grounds, deduced a parallax of 8 in. .836 = 0 ins. .004, which gives a mean distance of 92,504,000 miles with an exceedingly small probable error. With this value the sun's diameter comes out 861,670 miles.

Five new asteroids have been discovered this year. They are all exceedingly small bodies for primary planets, and are situated in that immense region between Mars and Jupiter. Five comets were discovered in 1889: two by BARNARD, of the Lick Observatory; one by BROOKS, of Geneva, N. Y.; one by DAVIDSON, of Australia; one by SWIFT, of Rochester, N. Y.

The principal astronomical phenomena of the year were two total eclipses of the sun—an unusual thing for any one given year—an occultation of Jupiter by the moon on September 3, visible all over the United States, and a very close apparent approach (conjunction) of Mars and Saturn (the first on record) September 10.

A very valuable discovery of great practical importance in the manufacture of astronomical telescopes has been made by two distinguished German physicists, Prof. ABBE and Dr. SCHOTT, of Jena, Germany. The great defect in all large telescopes of the refracting kind is the secondary spectrum, due to the fact that the lenses composing the object glass do not focus all the refracted rays at the same point. By using different kinds of glass, opticians have succeeded in bringing together two widely differing rays of light, the red and the blue, but have not succeeded in bringing together all the other intermediate rays, so as to form a colorless image, owing to what is called "the irrationality of dispersion." After numerous experiments and extensive research into the chemical nature of various kinds of glass, German physicists have succeeded in practically reducing the secondary spectrum, or the color correction, to zero in the new glass they have made. It is also claimed by the discoverers that the foci for visual and for photographic purposes are identical. All the telescopes hitherto made of the new glass have proved quite satisfactory in these respects.

CHEMISTRY.

A new metal has been discovered in both nickel and cobalt. Gnomium is the name proposed for it. Experiments on the compressibility of oxygen, nitrogen and hydrogen gases show that under a pressure of 15,000 lbs. per sq. in. the compressibility of these gases is no greater than that of liquids, and increases in proportion to the temperature. If the density of water be taken as unity, the density of oxygen under a pressure of 3,000 atmospheres is 1.1054, that of air 0.8817, of nitrogen 0.8293, and of hydrogen 0.0887. These facts have an important bearing on the physical constitution of the sun, whose interior is now regarded as a vast mass of gaseous matter under enormous pressure.

SOLAR PHYSICS.

M. JANSSEN, of Paris, has made an important discovery in solar physics. By spectroscopic observations made on the top of Mt. Blanc he has shown that oxygen does not exist in the sun. His observations show that the band and lines of oxygen previously identified by him and others in the solar spectrum are due entirely to the earth's atmosphere. These systems of lines in the red, yellow, and blue portions of the spectrum, which are known to vary with the square of the density of the absorbing oxygen, were altogether wanting, and the groups of dark lines in other parts of the spectrum, which vary simply as the density of the absorbing medium, were so faint as to leave no doubt of their total disappearance, provided we could entirely eliminate the effects of the earth's atmosphere. He has also repeated his observations on the top of the Eiffel Tower, and confirms his former results. Further researches in this direction are required to settle the matter definitely.

EXPLORATIONS.

During a course of deep sea soundings on a line extending from New Zealand to the Tonga or Friendly Islands, undertaken by her Majesty's ship, *Egeria*, an extraordinary depression of 5 miles and 168 feet was found in latitude 24 deg. 37 min. south, and longitude 135 deg. 8 min. west. Several other depressions were found near the same locality, varying from 3,006 to 43,00 fathoms, all of which appear to be crater-like depressions in a tolerably shallow sea.—*Baltimore Sun.*

A Manual of Railway Field Work and Laying Out of Works.

ACCORDING TO THE MOST RECENT AND APPROVED PRACTICE ON AMERICAN RAILWAYS.

BY A. M. WELLINGTON,
M.Am.Soc.C.E., M.Inst.C.E., etc.

[Copyright, 1889, by A. M. WELLINGTON.]

[The author will be pleased to receive typographical or other corrections, or suggestions as to form or substance, from any interested reader. All such suggestions will have full consideration.]

CHAPTER II. THEORETICAL PRELIMINARIES.

[*Continued from* p. 619.]

THE CUBIC PARABOLA is a curve which differs from a parabola in deviating from its tangent as the cube, instead of as the square of the distance from its tangent point; that is, its equation is of the form $y = mx^2$ instead of $y = mx^3$. This gives the two curves the decided difference of form shown in Fig. 45. The parabola is (for flat arcs) of nearly uniform radius. The cubic parabola is, of a constantly and rapidly decreasing radius, the "degree" of the cubic parabola increasing in nearly uniform ratio with the distance from the *P. C.*

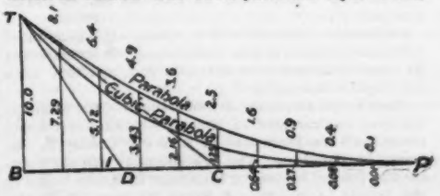


Fig. 45.

This property makes the cubic parabola a very suitable curve for the transition curves of railways. We shall not employ it for that purpose, but in preference thereto a curve deviating from it in much the same manner and to much the same extent that the circle differs from the parabola; that is, so slightly as to be practically identical with it for flat arcs, but having the advantage that it is more simply laid out. The close resemblance of the two curves, however, makes a summary of the properties of the cubic parabola desirable.

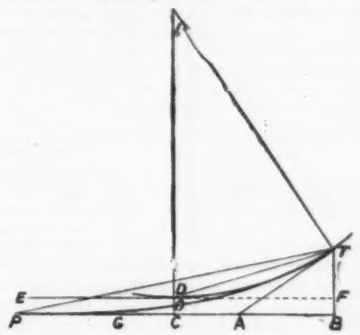


Fig. 46.

Let $P\,O\,T$, Fig. 46, be a cubic parabola, tangent to any given circular arc at T, and the two curves having at that point a common radius $I\,T$. Prolong the circular arc to the point D, in a tangent $D\,E$ parallel with the parabolic tangent $P\,B$. Draw $T\,B$ perpendicular to $P\,B$, and cutting $E\,D$ prolonged in F, and draw the radius $I\,D$ prolonged, cutting the curve $P\,T$ in O and the tangent $P\,B$ in C. Draw also the tangent $T\,A$ cutting $P\,B$ in A. Then the properties of the cubic parabola are such that we have the following:

1. $D\,C$ bisects $P\,B$ in C: that is, $P\,C = P\,B$, whence $P\,O = O\,T$ nearly.
2. The curve $P\,T$ bisects $D\,C$ in O, that is $D\,O = O\,C$.
3. $D\,C = \frac{1}{4}\,T\,F = \frac{1}{4}\,T\,B$.
4. $A\,B = \frac{1}{3}\,P\,B = \frac{2}{3}\,P\,A$; whence tan $T\,P\,B = \frac{1}{2}$ tan $T\,A\,B$.
5. The tangent of the angle $O\,G\,C$ (the line $O\,G$ not being drawn in on the cut to avoid confusion of lines) at any point O, being the angle between a tangent at O and the tangent $P\,B$, varies as the *square* of the abscissa of the point O along $P\,B$ as an axis; that is, $O\,G\,C$: $T\,A\,B :: \overline{P\,C}^2 : \overline{P\,B}^2$.

From this it follows that if C be the middle point of $P\,B$, angle $O\,G\,C = \frac{1}{4}\,T\,A\,B$.

Traversing, explained more fully in any treatise on surveying, is a method borrowed from navigation for detrmining rectangular coördinates with reference to an actual or assumed north and south line for the successive angle-points in a broken line, by which the latter can be conveniently plotted or the bearings and length of a single line, or of other lines, connecting the same points, determined. The several right lines are supposed to be defined by their length and bearing, i. e., by the angle A, Fig. 47, which they make with an actual or assumed north and south line. It is obvious that each line, as $O\,B$, must make a certain distance $C\,B$ east or west, called the *departure* (from a north and south line understood) and a certain distance north or south, $O\,C$, called the *latitude* (meaning the difference of latitude), the inferior limits of each being that if a bearing be due N. or S., the departure will be zero, and if it be due E. or W., the latitude will be zero. From Fig. 47 we have, letting n = the length of any line $O\,B$, and B = its bearing.

Fig. 47.

$$\left.\begin{aligned} \textit{Latitude} &= n \cos B \\ \textit{Departure} &= n \sin B \end{aligned}\right\} \qquad (\ )$$

These two formulas, abbreviated into the following four words "LATITUDE, *cosine*; DEPARTURE, *sine*," should be indelibly engraven on the memory of the young engineer. He will then never have to stop to reason out what angular function to take to compute any element of a traverse, and will thus save himself occasional error.

The latitudes and departures being determined

for each line of a series $O\ B\ D\ E$, it is obvious that their algebraic sum[1] will give the coördinate $F\ E$ and $O\ F$ of the terminal point E with reference to the initial point O. $F\ E$ and $O\ F$ being given, we have for the bearing of a single line $O\ E$ to connect the terminals:

$$tan\ B = \frac{F\ E}{O\ F}$$

and for the length of $O\ E$:

$$O\ E = \frac{E\ F}{sin\ B} = \frac{O\ F}{cos\ B}$$

Example.—The following three lines:

		cos.		sin	Lat. N	Lat. S.	Dep. E.	Dep. W.
N. 26, 30 E.	3. sta.	3. ×	.89493 &	.44620	2.695	—	1.339	——
N. 2, 40 W.	6.5 "	6.5 ×	.99892 "	.04653	6.493	—	——	0.290
N. 13, 30 E.	8. "	8 ×	.97304 "	.23032	7.784	—	1.845	——
Algebraic sum					16.962	—	2.894	——

When the distances are mostly even, natural sines and cosines are the most convenient for use in these computations: when mostly odd, the logarithmic functions. The above northing and easting being determined, we have

$$tan\ B = \frac{2.894}{16.962}$$

log	0.46150
"	1.22948
log tan	9.23202 (N. 9° 41′ E.)

Nearly all railway maps, except the large-scale field maps, are plotted by latitudes and departures determined in this way, but rarely in good practice by numerical computation, graphical computation by a diagram or traversing machine, Fig. 48, constructed on any large sheet of cross-section paper, being sufficiently accurate and vastly more rapid.

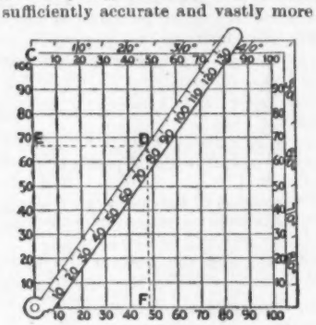


Fig. 48.

Of the cross-section papers in the market, metric paper, divided into square millimetres, is the most suited for this use. The paper is first mounted on a board, making sure that the lines all remain straight. A metal centre is then provided in the lower left-hand corner, the origin of co-ordinates, on which a sheet-metal arm swings, covered with a strip of the same cross-section paper as is used for the body of the diagram: taking great care that there shall be no irregular contraction of the paper, so that the scale of the arm and of the diagram shall be the same. Protractor graduations are laid off on the edges of the sheet, or on an arc across its face.

The instrument being thus constructed, the arm is first set for a given bearing, and the point D corresponding to the length of the line by scale is fixed. Holding this point on the diagram proper with a needle point, the arm is swung out of the way, and the latitude $D\ F$ and departure $E\ D$ at once read off. Exceedingly rapid and accurate work can be done in this way by proper care.[2]

In any closed figure, Fig. 49, it is obvious that the traverse should show in the aggregate as much northing as southing, and as much easting as westing; for, as the broken line surrounding the figure returns upon itself to the starting point O, the algebraic sum of both the latitudes and departures must be zero. In practice, this will only occur by accident, but any large error in the notes at once reveals itself, and any small error, due to the imperfections of the measurements and angular work, is distributed pro rata among the latitudes and departures. This method, therefore, which is explained more in detail in any treatise on surveying, furnishes an especially suitable method of plotting parallel and connecting lines or any other form of closed survey.

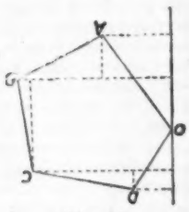


Fig. 49.

THE RECIPROCAL of any number, as a, is the quotient of $1 \div$ that number, or $\frac{1}{a}$. Hence, if we have to divide b by a we may instead multiply b by the reciprocal of a, because $\frac{b}{a} = b \times \frac{1}{a}$. Reciprocals are often highly useful for saving numerical work, especially when a small or even number is to be divided by a large or fractional number. For example, to determine the value of $\frac{3}{4}$ requires either the use of logarithms or considerable numerical work; whereas determining from a table that the reciprocal of 874 is .001144 + we have by merely mental computation $\frac{3}{4} = .003432 +$. Reciprocals are too little used by engineers in the field. In a large proportion of field computations not requiring the use of logarithms they are of advantage, and they reduce greatly the need for using logarithms.

AN OFFSET is a measurement, usually small, taken at right angles to a straight line or normal to a curve. A line is said to be offsetted when it is moved over bodily, parallel with itself, by a certain offset.

[1] *The algebraic sum or difference*, a term which we shall have frequent occasion to use and which should be already understood, means that regard is to be had to the + or − signs of the numbers in adding them together. Thus the algebraic sum of 2, 4, and − 5 is 1, and the algebraic sum of a and b East departures and c West departure is $a + b - c$.

[2] For further details as to the proper use of this instrument, see Ec. Th. Loc. Rys., Chap. XXXII.

The Railway Construction of 1889.

Since our last issue we have received reports making the following changes in our detailed list of the railway lines built in 1889:

ADDITIONAL MILEAGE.

Dover & Statesboro.—Dover, Ga., to Statesboro, Ga., 10 miles.

Flint & Pere Marquette.—On Saginaw (Mich.) Belt line, 8.12 miles. Instead of 3.41 miles as given last week.

Southwest Pennsylvania.—Latrobe, Pa., to Hostetter coke ovens and Latrobe to Latrobe Steel Works, 9 miles.

Total of additions, 23.71 miles.

MILEAGE TO BE SUBTRACTED.

Cape Fear & Yadkin Valley.—Wilmington, N. C. towards Fayetteville, 64 miles. (Instead of 75 miles as given last week.)

Astoria & South Coast.—Skipanon, Ore., to Carnahan's 6 miles. (Instead of 8 miles as given last week.)

Silverton.—Corkscrew to Albany, Col., 3.50 miles. (Instead of 3.75 miles as given last week.)

Making these deductions from the additions above, we have 12.46 miles to be added to the total of 4,970 miles reported last week.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

New York Central & Hudson River.—The annual report of this company for the year ending Sept. 30, 1889, gives the following results from operations:

Gross earnings	$35,696,236
Operating expenses and taxes	23,710,543
Net earnings	$11,985,693

Central Michigan.—At a meeting of the stockholders held Dec. 16, it was voted to build branches from Grand Rapids, Mich., to Bay City, to Manistee, and to Allegan. Surveys are already in progress for the branch from Grand Rapids to Allegan.

Baltimore & Ohio.—This company is building a 2-mile branch from a point near Taylorsville, Pa., to Hornstone quarry.

Louisville, Evansville & St. Louis.—It is announced that this company is now considering the extension of its Cannelton branch to Corydon, Ind., and that work will begin in the spring.

Cincinnati, Saginaw & Mackinaw.—This company has been incorporated in Michigan to build a railway from the Ohio State line in Lenawee County to the Straits of Mackinaw. The new company will also operate the Toledo, Saginaw & Mackinaw R. R. now leased to the Toledo, Ann Arbor & North Michigan R. R. Co., and will extend the line south to Cincinnati, O., instead of to Toledo, O., as was first intended.

Baltimore & Drum Point.—The grading of this Maryland road has been nearly completed in Calvert County, and the contracting forces will soon be transferred to Anne Arunde County.

Lower Laurentian.—This Canadian company has been recently reorganized and will complete the line as projected. The road is proposed to run from Three Rivers, P. Q., along the east bank of the St. Maurice River, crossing the Piles Branch of the Canadian Pacific R. R. at Piles Junction, and running to Riviere à Pierre, a distance of 74½ miles. The line from Piles Junction northeast 22½ miles was completed in 1887, and nothing has been done since. The new company proposes to build the division from the northern end of track to Riviere a Pierre, 22 miles, first, and the contract has been let to C. Scott, 105 Mountain Hill, Quebec.

Drummondsville & Richmond.—This road is to be extended from L'Avenir to Richmond, P. Q.

Wheeling & Lake Erie.—This company has increased its capital stock $2,000,000. The proceeds are to be used in building branches from Wheeling to Bellaire and from Portland to Steubenville, also to increase machinery, rolling stock, and terminal facilities.

Central Ontario.—This company has made an application to the Dominion Government for a subsidy to aid in building an extension from Coe Hill to Sudbury, a distance of 200 miles. The road will run through a fine mineral country.

Scioto Valley.—This road running from Columbus to Petersburg, O., 128 miles, will be sold at Portsmouth, O., Jan. 22, 1890.

Pennsylvania & Northwestern.—This is the name of the recently consolidated Clearfield & Jefferson, and Bells Gap railway companies. CHAS. F. BERWIND is President.

Pennsylvania.—It is stated that this company has abandoned the project of building a line from Phoenixville to Allentown.

Rockaway Valley.—Right of way has been obtained for an extension of this New Jersey road from Peapack to Morristown.

Projects and Surveys.

Troy & New England.—This company has been incorporated in New York to build a railway from Troy, N. Y., east to a point on the Massachusetts State line in Canaan Township, Columbia County, a distance of 35 miles. The directors of the road for the first year are: WILLIAM P. WARREN, CHARLES M. TILLINGHAST, WILLIAM A. THOMPSON, EDWARD MURPHY, JR., P. L. CUTLER, HENRY H. DARLING, LEWIS E. GURLEY, EDWARD F. MURRAY, CHARLES E. PATTERSON, WILLIAM KEMP, JAMES K. AVERILL, ANDREW J. SMART and EDGAR LYND.

New Jersey.—A press dispatch states that a surveying party is at work between Mendham and Chester, N. J., surveying a route for an air line railway between New York and Chicago. The route as now surveyed involves the construction of a tunnel 2½ miles long through Schooley's Mountain.

Hamilton Junction.—A bill is being applied for to incorporate a company by this name to build a terminal railway and station facilities at Hamilton, Ont.

Hamilton & Barton Incline.—This company has applied to the Canadian Government for a charter.

Mt. Moosilauke.—The surveys for this New Hampshire road have been completed and further work will be abandoned until spring. It is stated that a rack railway will not be necessary for the ascent of the mountain, as the grades are such as to permit of a friction road being operated.

Rockport, Evanston, St. Meinered & Ferdinand.—Incorporated in Indiana to build a railway from Rockport via Grand View, Newtonville, and Evansville to St. Meinered, Ind., a distance of about 35 miles. It is expected that work will commence soon and 15 miles of the road be completed early in the summer.

SOUTHERN.—Existing Roads.

Ohio Valley.—At a meeting of the directors recently held it was decided to build the extension of this road from Princeton, Ky., to Nashville, Tenn.

Louisville, New Orleans & Texas.—About 37 miles of the branch from Clarksdale to Yazoo City, Miss., is under construction.

Alabama Midland.—Work has been commenced on the Montgomery, Tuscaloosa & Memphis R. R. and it is expected that the line will be completed from Montgomery to the Alabama River in one month.

Louisville & Nashville.—It is rumored that this company will complete line from Birmingham, Ala., to Pensacola, Fla., during the coming year. A line is to be built from Blocton to Selma, Ala. From Selma the company already has a line to Pine Apple and by building a 20-mile line can connect with the Ripton Branch. This will give a line from Birmingham to Pensacola some 25 miles shorter than the present one.

Florence Dummy.—The grading of the dummy road at Florence, Ala., is completed and tracklaying will be finished by Jan. 15, 1890.

Projects and Surveys.

Pittsburg & Knoxville.—Incorporated in Virginia to build a railway from Pittsburg, Pa., along the Church River to Knoxville, Tenn.

White's Creek, Rockwood & Emory River.—Chartered in Tennessee to build a railway from a point on White Creek to a point on Emory River. J. TARWATER, of Rockwood, Tenn., is interested.

Orange & Keysville.—Surveys are in progress for a railway to run from Orange Court House to Keysville, Va., a distance of 95 miles. J. H. GRANVILLE, of Bremo Bluff, Va., is Chief Engineer.

Iron Belt.—This company has been organized in Tennessee to build a railway from Morristown to Cumberland Gap.

NORTHWEST.—Existing Roads.

Chicago & Northwestern.—At a meeting of business men recently held at Mitchell, So. Dak., a committee was appointed to confer with the officials of this road in regard to an extension from Mitchell to Wheeler, So. Dak.

Duluth & Winnipeg.—At a meeting of the stockholders recently held the following Board of Directors was elected: A. P. WRIGHT, C. W. WELLS, Saginaw; T. B. CASEY, Minneapolis; W. H. FISHER, St. Paul, E. D. CHILDS, Crookston; Sir RODERICK CAMERON, New York; DONALD GRANT, Faribault; H. S. HOARDMAN, Boston; R. S. MUNGER, Duluth. It is announced that the road will be extended to the International boundary immediately.

Union & Southwestern.—An official of this company is reported as saying that the contracts for 100 miles of its road would be let in a short time.

Northern Pacific.—A rumor is in circulation that this company and the Wisconsin Central R. R. Co. will be consolidated under one management. The consolidated company will be known as the Grand Central R. R. Co.

Pacific Short Line.—Grading has been resumed on this road west of Plainview, Neb. It is expected to have the line in operation from Sioux City, Ia., to O'Neill, Neb., by May 1, 1890.

Projects and Surveys.

Freeport, Ironton, Mauston & Northern.—At a meeting of the stockholders of this Wisconsin road recently held, it was voted to begin the preliminary surveys for the line at once. The road is projected to run from Dexterville, Wis., via Mauston and Ironton to Lone Rock, Wis., a distance of about 95 miles. The officers are: JEFF. I. HEATH, President; F. WINSOR, Vice-President; T. L. ALSBACHER, Treasurer, and G. H. WINSOR, Secretary.

Sioux City & Northeastern.—This company asks a 2 per cent. tax from Sioux City, Ia., in aid of its proposed road. The road is to run from Sioux City, Ia., northeast to a point in Woodbury County, Ia., a distance of 38 miles. The line is to be completed by Jan. 1, 1891.

SOUTHWEST.—Existing Roads.

New Orleans, Natchez & Fort Scott.—This company has signed a contract to build its road to Bastrop, La.

Kansas City, Nevada & Ft. Smith.—Work on this road is being rapidly pushed. The line has been surveyed as far as Foster, Mo., about twenty miles north of Nevada, and when the road is completed between Kansas City and Nevada work will immediately begin on the line from Nevada to Monett, Mo., and from there to Fort Smith, Ark. Grading on the division from Walker, a station nine miles east of Nevada, to El Dorado Springs, will be completed inside of three weeks, when the laying of iron will begin.

Toledo, St. Louis & Kansas City.—The narrow gauge portion of this road from Charleston to East St. Louis, Ill., 131 miles has been changed to standard gauge during the year. The change of gauge has been accompanied by extensive improvements on the whole system. The entire roadbed has been widened and the line changed at a great many places to avoid sharp curves. A large amount of work has been done on the western portion of the road toward reducing the east-bound grade from a maximum of 52 ft. to one of 40 ft. to the mile, and it is expected that the work will be completed by next month. The rebuilding of the bridges has been almost entirely completed, and many of the trestles have been filled up and replaced with solid embankment. At the most important rivers new iron and steel bridges have been erected on substantial abutments, the most notable of which is at the crossing of the Wabash River, near Silverwood, Ind., at which place a five-span iron and steel bridge, 825 ft. long, has been erected. One hundred and seventy-five miles of track have been relaid with 61½-lb. steel rails, and about 350 miles of track have been ballasted with gravel and broken stone.

Projects and Surveys.

Arkansas & Gulf.—Chartered in Arkansas to build a line of railway from a point on the Louisiana State line north to a connection with the Stuttgart & Arkansas River R. R., on the Arkansas River, a distance of 85 miles. Among the incorporators are: JOHN D. ADAMS, and LOGAN H. ROOTS; both of Little Rock, Ark., WM. BOOMER, of Arkansas City, Ark., and C. F. ODELL, of New York City.

Gulf & Northwestern.—A railway company by this name has been chartered in Texas by H. J. SUTCHER, G. B. MEORE, D. CALL and others.

Fort Worth & Albuquerque.—In an interview with the reporter of the *Las Vegas (N. Mex.,) Optic*, GEORGE LAIL, of Albuquerque, N. Mex., spoke as follows concerning this road, which is projected to run from Ft. Worth, Tex., to Albuquerque, N. Mex.:

> It's all bosh, the talk about building that road. In the first place, it has never even been surveyed; in the second place, they haven't got any money to build it with; in the third place, there are no inducements whatever, to build such a road as there is no timber, no mineral, no coal, no nothing except some sage brush, cactus, and horned frogs.

Langdon, Rockport & Northern.—Incorporated in Missouri to build a railway 6 miles long from Langdon to Rockport, Mo.

ROCKY MT. AND PACIFIC.—Existing Roads.

Rio Grande Western.—This company has let the contract for the 25-mile extension from Thistle towards Maryville, Utah.

Seattle & Northern.—The contract for furnishing 90 000 ties for this road has been let to McKenzie & Gibbon, of Renton, Ore. The ties will be used on the 20 mile division between Anacortes and Sedro, which was graded last summer. The rails for the line are on hand and it is expected that this division will be completed by July 1, 1890. Dunham & Collins, have commenced work on the large wharf at Anacortes. The officers of the company are: ELIJAH SMITH, President, H. W. MCNEAL, Vice-President, HAYDEN MCLELLAN, Secretary, and F. A. HILL, Chief Engineer.

Union Pacific.—It is stated that this company is about to reopen the Colorado Central R. R. between Ft. Collins, Col. and Cheyenne, Wyo., and that work is already in progress. The old rails and ties are being torn up and the roadbed is being surfaced and new ties and rails are being laid.—A press dispatch quotes President ADAMS as saying;

> The Union Pacific does not propose at present to fry and cover the earth. The entire Union Pacific system will only build 200 miles of additional road next year; 145 miles on the Oregon Short Line system to Pocatello, where the line will rest for the present; thirty-five miles to connect the Cheyenne & Northern with the Elkhorn division of the Chicago & Northwestern system, and twenty miles to make some connections in Kansas. All the stories now current in newspapers as to plans and extensions and purchases of the Union Pacific on the Pacific slope are pure inventions absolutely without basis.

FOREIGN.

Monterey & Mexican Gulf.—All the laborers on the Tampico division of this road have been transferred to the section between Monterey and Venadito and work is to be pushed so as to complete the line by March 1. When this division is completed, work will be resumed on the line to Tampico. The following officers and directors were elected at the recent annual meeting: President, GERONIMO TREVIÑO, Mexico; First Vice-President, THOMAS S. BULLOCK, New York; Second Vice-President, J. J. FISHER, St. Louis, Mo.; Third Vice-President, EMETERIO DE LA GARZA, Mexico; Secretary and Treasurer, V. A. WILDER, New York, and General Manager, J. A. ROBERTSON, Monterey, Mexico. Directors: GERONIMO TREVIÑO, THOMAS S. BULLOCK, J. J. FISHER, EMETERIO DE LA GARZA, V. A. WILDER, J. A. ROBERTSON, and FRANK RUDD.

Cerdan.—Tracklaying has reached Tacubaya, on this Mexican road, and the grading has been completed as far as Mixcoac.

Colombia Railway & Navigation Co.—This company, notice of whose application for a charter was given in our last issue, has been incorporated in Virginia with a capital stock of $100,000,000. The object of the company is to establish a line of steamships from the Gulf ports of the United States to the mouth of the Magdalena River, in the United States of Colombia, and from this point to build a railway south, along the eastern flank of the Andes Mountains and the headwaters of the Amazon River to points in Peru, where connection will be made with the Peruvian system of railways. Capt. H. C. PARSONS, of Natural Bridge, Va., is at the head of the enterprise.

San Salvador.—Construction on the line from Ateas to Guarumal is making good progress, both tracklaying and grading going on.—About $300,000 have been subscribed in aid of the road from Santa Ana to Armenia.

Alcoy & Gandia.—Bonds are being marketed to aid in the construction of this railway from Alcoy to the harbor of Gandia, Spain, a distance of 43 miles. The route is through a fine wine-producing country. The engineers are: Brunlees & McKerrow, 12 Victoria St., Westminster, London.

RAPID TRANSIT.

Electric Railways.—*Boston, Mass.*—The West End St. Ry. Co. will operate its line to Malden by electricity, and will build a line from Brookline to Townsend.

Braintree, Mass.—The Braintree Electric St. Ry. Co. has been incorporated by Hon. F. A. HOBART, JAMES T. STEVENS, ELISHA THAYER, and others. Capital stock, $25,000. The road will be 7 miles long.

Springfield, Mass.—The Springfield St. Ry. Co. has been granted permission to operate its line from State St. to Forest Park by electricity, using the single trolley system.

Philadelphia, Pa.—The Philadelphia Traction Co. has been experimenting with two Edco storage battery cars on the line to Darby.

Pittsburg, Pa.—The Suburban Electric Ry. Co. will extend its line into the city. Work will be commenced in the spring.

Blacksburg, S. C.—The Blacksburg St. Ry. Co. has been incorporated by J. F. JONES, W. W. HARDIN, and F. P. BEARD.

Macon, Ga.—The Macon dummy line is to be converted to an electric system. President, WM. J. COITE, of Philadelphia; Secretary, GEO. F. WORK, of Philadelphia; General Manager, E. S. WINTERS.

Birmingham, Ala.—The Birmingham St. Ry. Co. contemplates adopting electric traction.

Fremont, O.—The new street railway will be equipped for electric traction by June.

Belleville, Ill.—The Citizen's Ry. Co. has been granted permission to operate its lines by electricity.

Boone, Ia.—The street railway company has applied for permission to operate its line by electricity.

Colorado Springs, Col.—The Colorado Springs & Manitou St. Ry. Co. proposes to increase its capital stock from $100,000 to $200,000 to pay for equipping the line with an electric system.

Denver, Col.—The Denver & Suburban Ry. Co. proposes to operate its line by storage battery cars.

Oakland, Cal.—The Oakland & Berkeley Rapid Transit Co. has filed a bond of $20,000 for the construction of the electric road on Grove St.

San Francisco, Cal.—The North Beach & Mission Ry. Co. contemplates adopting an electric system.

Cable Railways.—*Portland, Ore.*—The Portland Cable Ry. Co. has asked for a franchise for extending its roads, and has offered to build a bridge at a cost of $20,000.

Montgomery, Ala.—The Montgomery Terminal & St. Ry. Co. is contemplating the adoption of cable traction.

Pueblo, Col.—The money has been raised for the proposed cable road, and construction will soon be commenced. Hon. J. N. CARLILE is interested.

Dummy Lines.—*Liberty, Mo.*—Capt. GUSTAVE DYES is surveying for a dummy line to Kansas City. Mr. W. E. WINNER is interested.

Centerville, Cal.—A franchise for a dummy line between Centerville and Huron has been granted to Dr. E. B. PERRIN, of San Francisco, and J. R. WHITE, of Fresno.

Elevated Railways.—*Boston, Mass.*—The West End St. Ry. Co. is said to have bought out a company which proposed to build an elevated road, and intends to build an electric line over the route.

Brooklyn, N. Y.—The Kings County Elevated Ry. Co. has issued $1,250 000 in bonds, being a part of an issue of $1,650,000 authorized at the rate of $550,000 per mile on 3 miles of extensions now completed.

New York, N. Y.—The Aldermen have appointed a committee to facilitate, if possible, the extension of the Suburban Rapid Transit Ry. from the terminus at 170th St. to Fordham.

Incline Railway.—*Cincinnati, O.*—The Mt. Auburn inclined plane, on which a serious accident occurred last fall by the breaking of the cable, has been entirely rebuilt and equipped with new plant.

Street Railways.—*Albany, N. Y.*—The Watervliet Turnpike Ry. Co. will extend its line from West Troy to Cohoes.

Syracuse, N. Y.—The Woodlawn & Butternut St. Ry. Co. proposes to build extensions to make the road a belt line.

Pittsburg, Pa.—A franchise for lines on several streets has been granted to the East End Ry. Co.

Harrisburg, Pa.—The East Harrisburg Passenger Ry. Co. will increase its capital stock from $100,000 to $150,000, and extend its line beyond Steelton.

Pensacola, Fla.—A street railway is to be built on Government and Palafox Sts. to Kupfrian's Park.

Corvallis, Ore.—The Corvallis St. Ry. Co. has been incorporated by ZEPHIN JOB, J. H. WILSON, and RALSTON COX. Capital stock, $50,000.

HIGHWAYS.

Pennsylvania.—The Agricultural Society's last meeting was an unusually large and interesting one. The main subject under discussion was the making of better roads, and how to keep them in better condition. Mr. S. R. DOWNING, of Chester County, read a very lengthy paper, in which the building of macadam roads was strongly advocated. He insisted it was the only road that would give satisfaction the whole year through, and declared it could be built far more cheaply than was commonly believed. He regarded it as good policy for townships to borrow the money required to build them because of the saving in horse flesh, vehicles, harness, time, etc., and because larger loads can be drawn on them. The persons in attendance were largely road supervisors and men interested in having good roads. All admitted that the roads as we have them are poor and much in need of improvement; all admitted the difficulty of doing this; all denounced the existing methods, their cost and their inefficiency, and yet nearly all deprecated the cost of making macadam roads. They wanted good roads, but were unwilling to pay for them. Good things cost money, however, and unless the State can be persuaded to lend its aid we fear good roads will not come for some time.—*Lancaster, Pa., New Era.*

New Jersey.—Passaic County is taking measures for the improvement of some of its roads, including those which join Essex County, and the work when done will be of advantage to this vicinity as well as that county. A committee of its Board of Chosen Freeholders has mapped out a line of road improvements for next Spring, and

County Engineer C. V. W. FONDA is engaged in preparparing plans and profiles for the work. The roads will be macadamized.

Kansas.—A new road is to be built by the farmers from Stillingstown to Beverly.

Colorado.—The La Plata County Improvement Co. has been incorporated at Durango, Col., by W. E. CHAPMAN, J. PREWITT, H. H. STRATEN, and others, to build a wagon road from Rockwood to Rico. Capital stock, $10,000.

Massachusetts.—Mr. WINKLER, Superintendent of the Highway Department of Holyoke, Mass., has presented his annual report. The expense of caring for the streets increases year by year through the difficulty of obtaining gravel and other material. The problem of where to get good road covering faces the department. As the putting in of stone paving on Main St. has reduced the cost of maintaining the highway from several hundred dollars to almost nothing, the superintendent recommends a liberal appropriation to pave the principal streets. In time the streets must be macadamized, which costs less than block paving, and is not more expensive than frequent graveling, while it gives much better service. A steam roller, 15 tons in weight, and a horse sweeper are recommended to be procured.

CONTRACTING.

Excavation.—The contract for excavation at the Congressional Library Building, Washington, D. C., has been awarded by BERNARD R. GREEN, Superintendent and Engineer, to Thos. H. Lyons, of Washington, at $3,175. The other bidders, all of Washington, were as follows: James O'Day, $4,992; Maurice F. Talty, $4,950; W. H. Mohlor, $3,950; C. M. McClay & J. H. Murphy, $4,876; Andrew Gleason, $3,353, J. P. Largney, $4,175; Michael Mahoney, $5,269.55; George Killeen, $4,800.75; M. Burke & W. P. Collins, $5,675; J. Frawley, $4,200; J. S. Ellis, $5,550; Michael Shea, $5,200.

Dry Dock.—The Mobile Dry Dock Co., of Mobile, Ala., has been organized at Mobile, Ala., to build a dry dock at an estimated cost of $150,000.

Ties.—Proposals for 90,000 ties have been received by F. A. HILL, Chief Engineer, Seattle & Northern Ry., Seattle, Wash.; McKinzie & Gibbons bid 35 cts. per tie, and Dunham & Collins 38 cts.

Sea Wall.—The Town Council of Bristol, R. I., will build a sea wall 100 ft. long.

Railway.—A contractor with capital is wanted to build a city railway 7 miles long; considerable wooden bridge work, draws and piling. BYRON ANDERSON, 45 Broadway, New York.

Cement.—The following proposals for cement for the Congressional Library Building have been received by B. R. GREEN, Engineer, Washington, D. C.: Cumberland Hydraulic Cement Co., $1.05 5-12 per bbl., 85 cts. per bag J. G. & J. M. Waters, Washington, $1.04, 90 cts. Union Cement Co., $1.34, $1.98.

Levees.—The following work has been staked out by F. M. KERR, Assistant State Engineer of Louisiana: At Staten Point, 16,500 ft. in length, and estimated to contain 65,000 cu. yds. of earth; at Durfresne's, 7,600 ft., estimated at $22,000 cu. yds.; at Eagle Bend, 841 ft., estimated at 6,700 cu. yds.; at Dixie's plantation, 2,240 ft., containing 6,500 cu. yds., and in Rossier parish, 8,890 ft. containing 20,000 cu. yds.

Chief Engineer STARLING, of the lower Mississippi levee district, with headquarters at Greenville, Miss., reports that all work on the district's levees will be completed in January. By that time the entire line of levees, 200 miles long, will be brought to a level 5 ft. above high water of the year 1888, and 850,000 cu. yds. of earth will have been placed on them. Of this immense mass 10,000 yds. is enlargement and raising levees and 240,000 yds. for building new levees at Hall's landing and Clover Hill. The total expenditure of the Levee Board for this work is $210,000. In addition to this $75,000 will be expended in taking up levee bonds issued in 1882.

Sewers.—*Tonawanda, N. Y.*—The following proposals have been received by R. F. BETTS, City Engineer: D. F. Minnehan, Springfield, O., 107,285; Charles Bayer, Buffalo, N. Y., $117,910.06; McConnell & Rogers, Tonawanda, $132,966.43; W. A. Green, Buffalo, N. Y., $151,821.17 Wm. G. Smith, Buffalo, $164,976.63; Franklin & Olson, Buffalo, $170,335.50; Van Vranken & Duell, Schenectady, also made a bid. The contract was awarded to D. F. Minnehan.

Sidewalks.—*Brooklyn, N. Y.*—The following proposals for concrete walks have been received by the Department of Parks: Wilson & Baillie Mfg. Co., 23 cts. per sq. ft.; Matthew Taylor Paving Co., 23½ cts.; D. F. Blaney & Co., 25 cts.; Schillinger Fire Proof Cement & Asphalt Co., 27 cts.; John A. Chrystie, 28 cts. The contract was awarded to the Wilson & Baillie Mfg. Co.—For flagging sidewalks on Evergreen Ave, John Morrissey bid 24½ cts. per sq. ft.

Building.—Bids have been opened by the Supervising Architect, Treasury Department, Washington, D. C., for iron work for the construction of the first floor of the custom house in Port Townsend, Wash. The bids were as follows: F. J. Myers, $4,350; C. H. Wobymans & Co., $12,000; Stewart Iron Works, $5,100; Dearborn Foundry Co., $3,940; Clark, Ruffin & Co., $3,807; L. Schreiber & Sons, Cincinnati, $3,898; St. Paul Foundry Co., St. Paul, Minn., $3,900; Marshall Foundry Co., Pittsburg, $6,000.

Jail.—The new county jail at Portland, Ore., has been accepted by the County Commissioners. It was built by J. H. Van Dorn, of Cleveland, O. The contract price was $11,000, and the work includes, sixteen main and two minor cells, plumbing complete, and piumbing for the dark and padded cells.

Dredging.—The following proposals have been received by Gen. Wm. T. SMITH, U. S. Engineer Office, Wilmington, Del., for dredging in Broadkiln River, Delaware: American Dredging Co., Philadelphia, Pa., 7 cts. per cu. yd.; Atlas Dredging Co., Wilmington, 12 cts.; National Dredging Co., Wilmington, 23 cts.

Sewers.—The following proposals have been received by Mr. E. OGDEN ROSS, Secretary of the Contracting Board, Troy, N. Y., for 530 ft. of 15-in. tile sewer, with cesspools and manhole: E. Broderick & Son, Troy, $2.21½ per lin. ft.; Malone & McKenna, Troy, $1,055.40; J. H. Cavanaugh, Troy, $1,022.90, or $1.93 per lin. ft. The contract was awarded to J. H. Cavanagh.

PROPOSALS OPEN.

Iron Work and Gates.—Iron floor, ladders, gates, gate-lifts, etc., at inlet tower at the Chain of Rocks. HENRY FLAD, President, Board of Public Improvements, St. Louis, Mo. Jan. 7.

Sewers and Street Work.—Brick and pipe sewers, excavation, curbing, flagging, etc. The COMMISSIONERS OF PUBLIC PARKS, 49, 51 Chambers St., New York City. Jan. 8.

Water-Works.—Plans, specifications and bids. E. W. BARTLETT, City Attorney, La Grande, Ore. Jan. 11.

Canal Work.—Improving the Glens Falls Feeder of the Champlain Canal: (No. 1.) For improving 570 lin. ft. of the Glens Falls Feeder. (No. 2.) For improving 360 lin. ft. of the Glens Falls Feeder. (No. 3.) Building waste weir, spillway and sluiceway at combined Locks 2 and 3, Glens Falls Feeder, 3 bailing and draining; 4,700 cu. yds. excavation of earth, etc.; 1,000 cu. yds. excavation of rock; 50 cu. yds. excavation of old masonry; 1,480 cu. yds. embankment; 975 cu. yds. lining; 100 cu. yds. procuring and puddling; 1,087 cu. yds. concrete masonry; 1,643 cu. yds. vertical wall in cement including coping; 20 cu. yds. rip rap; 75 cu. yds. coursed masonry in dam and waste weir (including coping); 12,500 ft. B. M. white oak timber and plank per M.; 16,000 ft. B. M. white pine timber and plank per M.; 36,500 ft. B. M. hemlock timber and plank per M.; 570 sq. yds. pointing old wall; 1,200 lbs. wrought iron; 575 lbs. cast iron; 2,150 lbs. spikes and nails. Deduct materials furnished by State—60 cu. yds. of old vertical wall stone at $1.50, $90; 20 cu. yds. of rip rap stone at $1, $20. The following are the estimated quantities for (No. 4) improving the Oneida River 20,000 cu. yds. excavation under water; 6,000 lin. ft. white oak piles furnished and driven; 12,000 ft. B. M. white oak timber; 1,000 lbs. wrought iron. EDWARD HANNAN, Superintendent of Public Works, Albany, N. Y. Jan. 14.

Cut Marble.—For Court House extension. Bingham & Spofford, Architects, 27 Mt. Vernon St., Boston, Mass. Jan. 14.

Brick.—About 550,000 hard-burnt bricks for the arches of the water-power dam wall. The dimensions of brick preferred are 8½ x 4¼ x 2½ ins. Each bidder must submit a sample of the bricks he proposes to furnish. Col. JAS. M. WHITTEMORE, U. S. A., Rock Island, Ill. Jan. 16.

Dredging.—W. P. RICE, City Engineer, Cleveland, O. Jan. 17.

Iron Work.—For the cruisers,—bolts, steel plates, rods, etc. F. M. RAMSAY, Acting Secretary of the Navy, Navy Department, Washington, D. C. Jan. 23.

Sewers.—Plans and specifications on file. GEO. R. BRINGHURST, City Secretary, Houston, Tex. Jan. 27.

Jail.—Cell work for new county jail. E. R. JEFFERSON, care of County Auditor, Duluth, Minn. Jan. 30.

Jail.—Cages, gratings, doors, windows, etc. W. R. FORREST, County Auditor, Seattle, Wash. Feb. 3.

Bridge.—Iron bridge over the Chattahoochee; 2 spans of 150 ft., 400 ft. of trestle, masonry piers and abutments. J. T. COOPER, Clerk of County Commissioners, Atlanta, Ga. Feb. 5.

MANUFACTURING AND TECHNICAL.

Switches and Frogs.—We are informed that the Parsons Block, Switch & Frog Co., of New York, will put one of its patent safety switches and frogs on the main crossover track at one end of the Brooklyn Bridge.

Pressed Steel.—The Schoen Mfg. Co., of Philadelphia, which manufactures pressed steel articles for railway equipment, is building new works at Pittsburg, Pa.

The Belleville Stone Co., has been incorporated at Newark, N. J., by ROBERT ELLEN, of Yonkers, N. Y.; Jos. J. SPURR, of Newark; ANDREW BARR, of Annandale; SAM'L KITSON, of Washington, D. C., and JOHN N. HARRISON, of New York.

The Diebold Ballast Co. has been incorporated at Pittsburg, Pa., by CHAS. DIEBOLD and others, to manufacture railway ballast from slag.

Garbage Cremation.—The Chicago Garbage Crematory Co, has been incorporated by BERNARD C. HEAVEY MORTIMER SCANLAN, and JOHN GRIFFIN. Capital stock, $50,000.

Roller Bearings.—The American Roller Bearing Co. has been incorporated at Chicago, by HERMAN HAUPT, Jr., T. E. SHAEKE, and E. D. AGLE. Capital stock, $1,000,000.

Asphalt Blocks.—The Trinidad Asphaltum & Block Pavement Co. has been incorporated at Fort Payne, Ala. President, HENRY B. PIERCE. Capital stock, $40,000.

Ten-Wheel Locomotives.—A daily paper has the following note:

One of the new ten-wheelers on the Big Four recently hauled 34 car-loads of Pittsburg coal from North Bend to Indianapolis, and it is believed that it will be safe, after the engines are once limbered up, to rate them at 40 cars of 60,000 lbs. capacity. The heavy mogul engines are rated to haul 23 to 24 car-loads of coal between the points named.

Shay Locomotives.—The Salt Lake & Eastern Ry. will use two Shay locomotives, weighing 40 tons each.

Cars.—The Lima Car Works, of Lima, O., are building 30 tank cars for the Shawnee Oil Co.

The Pullman Car Co. has built ten electric cars for the Federal St. & Pleasant Valley Ry. Passenger Co., of Pittsburg. They have two emergency brakes. One is applied by the electric current, and the other by the regular lever on the platform. Besides these, each car is provided with rail brakes. The latter, when applied, press down against the rails.

The Laclede Car Co., of St. Louis, Mo., has received an order for 40 cable cars for the Metropolitan cable line of Kansas City, and for 9 grip cars for the Kansas City Cable Co.

The Lake Shore & Michigan Southern has contracted for 3,700 freight cars to be delivered before spring business opens.

The Burlington & Missouri River has ordered 2,000 new freight cars, to be delivered Feb. 1.

The Columbia Buffet Stock-Car Co., of Chicago, has been incorporated by SAMUEL LAZARUS, HENRY S. BOICE, HENRY W. CRESWELL, and others. Capital stock, $500,000.

The Litchfield Car Co., of Litchfield, Ill., has a contract for 2,000 freight cars for the Cleveland, Cincinnati, Chicago & St. Louis.

The Georgia Central will enlarge its works at Macon, Ga., to have a capacity of building 20 passenger cars and 500 freight cars per annum.

Locomotives.—The Schenectady Locomotive Works, of Schenectady, N. Y., have an order for 4 freight engines and 1 switching engine for the Kentucky Central.

H. K. Porter & Co., of Pittsburg, Pa., have an order for 2 passenger engines for the Salt Lake & Eastern.

The Rogers Locomotive Works, of Paterson, N. J., have built 5 freight engines for the Shenandoah Valley.

The Brooks Locomotive Works, of Dunkirk, N. Y., have recently delivered to the New York Central ten mogul engines for fast freight service; they have cylinders 19 by 26 ins., drivers 64 ins. diameter, boilers 58 ins. diameter; they are equipped with driver brakes and weigh 130,000 pounds. They are building 10 ten-wheel engines for passenger service, and 5 switch engines for the Cleveland, Cincinnati, Chicago & St. Louis; the former have cylinders 19 by 24 ins., drivers 62 ins. diameter, and weigh 128,000 lbs; the latter have cylinders 18 by 24 ins.

Locomotive Works.—The Grant Locomotive Works, of Paterson, N. J., will, it is said be removed to Chicago, where a site has been purchased. It is reported that Mr. E. T. JEFFREY, formerly General Manager of the Illinois Central, will be superintendent.

Car Wheels.—The Pennsylvania Rolled Steel Car Wheel Co. has been incorporated at Harrisburg, Pa., with a capital stock of $1,000,000.

Wrought-Iron Pipe.—At a recent meeting of the National Association of Wrought-Iron Pipe Manufacturers, at Pittsburg, Pa., it was decided to be inexpedient to advance prices, in spite of the advance in price of raw material. The prospects for 1890 were reported to be good, but without prospect of any extraordinary demand.

The Pond Engineering Co. will furnish and erect a complete steam plant of 75 H. P., at Murphysboro, Ill. A 150 H. P. Armington & Sims engine has been shipped to the Edison Electric Illuminating Co., of New Orleans, making the sixth engine furnished. A 50 H. P. boiler is being furnished for the Ice Co., at Corpus Christi, Tex., an automatic feed pump and receiver, in Kansas City, and leather link belt to the Holden, Mo., electric plant, and the St. Louis Smelting & Refining Co.

Filters.—The National Water Purifying Co. reports a contract closed for a battery of 10 ft. diam. National filters, for the water works at Caldwell, Kan.

Drilling and Threading Machines.—An improved form of machine for drilling and threading, or tapping, is being introduced by HENRY F. JENKS, of Pawtucket, R. I. The machine consists of an upright frame, 41 ins. in height, occupying a floor space of about 20 by 36 ins.

To the frame is attached a horizontal table which can be moved up or down by a screw to suit the work. On this rests a sliding table to which either the jig or the pieces of work are attached. The movement of this table is controlled by adjustable stops which regulate the depth of the hole to be drilled or tapped. The spindle, to which the chucks or bushings are attached, is hollow; the reverse motion is attained by very powerful and sensitive friction within the pulleys. With this machine, the hole is accurately aligned, whether it goes clear through, or part way. Holes may be tapped to the bottom without danger of breaking the taps. The work is secured to a sliding table, and the drills and taps used are held by a chuck. After drilling the holes, the drill is removed, when the tap is placed in the chuck or bushing to do the tapping. Taps may be used from 1-16 in. diameter or smaller, to 5-8 in.

The Joseph Dixon Crucible Co., of Jersey City, N. J., reports that it closes 1889 with satisfaction. The business has been larger in every branch than in 1888. The chief new departure has been in the large increase of equipment at the graphite mines at Ticonderoga. The lines have been laid there for a five years' continuous run, tearing down and rebuilding almost everything much larger than before. The prospects for 1890 are reported to be good.

The Hyatt Pure Water Co., reports a number of city plants put in operation during the year, including Ashville, N. C., Richfield Springs, N. Y., Stevens Point, Wis., Lakewood, N. J., New Brighton, Pa., Morganza, Pa., Trenton, Mo., Shreveport, La., while the plants longest in operation, Somerville, N. J., Atlanta, Ga., Long Branch N. J., etc., have not failed to give pure water continuously and uninteruptedly since they were started. Among the larger plants put in for other than city use are the following: John N. Stearns Co., Peterburg, Va., Harrison Frazer Sugar Refining Co., and Quaker City Dye Works Co. Philadelphia, Booth & Co., Gloversville, N.Y., Parsons Paper Co., Holyoke Mass Penn Steel Co., Harrisburg, Pa., Pelican Brewing Co., New Orleans, La., W. Dewees Wood & Co., McKeesport, Pa., Star Crescent Mills Co., Philadelphia, Pa., Polar Ice Co., Agusta, Ga., Chelsea China Co., New Cumberland, Pa., Union Oil Co., New Orleans, La., Sugar Refining Co., Duquesene Club Pittsburg, Pa., Stearns & Foster Co., Cincinnati, O. Eberhardt & Ober Brewer Co., Allegheny, Pa., Pacific Union Club, Planters Sugar Refining Co., Hon. LEVI P. MORTON, Edison Phonograph Co., Brooks Locomotive Works, Dunkirk, N. Y., Franenheim & Bilsack Brewing Co., Pittsburg, Pa., Senator GEO. HURST, Thompson Houston Electric Co., etc.

BRIDGES AND CANALS.

Bridge Notes.—***Boston, Mass.***—The Committee on bridges has reported an order requesting the Mayor to petition the General Court for the passage of an act authorizing the city of Boston to build a bridge from the city proper to East Boston. The committee is of the opinion that the interest upon the cost of a bridge would not exceed the expense of maintaining the ferries. The matter was referred to the next City Government.

Staten Island.—A bill has been introduced in the New York Legislature by Senator HISCOCK authorizing the New Jersey Bridge & Railway Co. to build a pivot draw or lift bridge across Staten Island Sound or Arthur Kill from the town of Westfield, S. I., to a point in Middlesex County, N. J., to be used for wagon and railway purposes; all railway companies desiring to use it to be granted equal facilities; it is to be 32 ft. above high water. The same company is also authorized to build a suspension or cantilever bridge over the Kill von Kull from the north side of 3rd St. or York Ave., New Brighton, to a point at or near Constable's Point, N. J. This is to be not less than 127½ ft. in the clear above mean high water, with a channel span of 600 ft. Both bridges are declared to be post routes.

Greenbush, N. Y.—Plans for the bridge at the Broadway crossing have been submitted to the Trustees by Mr. ALGER, engineer of the Boston & Albany R. R.

Hampton, Va.—The county will issue bonds for an iron bridge 650 ft. long and 35 ft. wide. For particulars address S. B. C. Lake.

Louisville, Ky.—Mr. R. T. SCOWDEN, City Engineer, has awarded contracts to C. L. Cornwell, as follows: steel joist bridge complete across Beargrass Creek at Payne St., $64 per ft., $2,816; iron truss footway bridge across Beargrass Creek, at Reservoir Ave., $20.50 per ft. $1,435.

Columbia, S. C.—A bill has been introduced in the Legislature to authorize Lexington County and the city of Columbia to issue $50,000 of bonds to purchase the Broad River and Congaree Bridges, or erect others.

Jacksonville, Fla.—The new railway bridge over the St. John's river has been opened.

Jeffersonville, Ind.—The Board to examine and report upon the best site for the proposed bridge over the Ohio, between Louisville, Ky., and Jeffersonville, Ind., recommend that the bridge be located at or above Wall St., Louisville, with a channel span of at least 500 ft. in the clear at low water line on the Indiana shore, and a similar span on the William Island shore, the water face of the shore piers of these spans being at the low water line. The bridge will be 29 ft. wide, and have a single railway track and two footways. Wagons are to be transported on floats drawn by an engine. The spans, beginning on this side, will be 210, 550, 553, 550, and 341 ft., altogether 2,545 ft. from shore to shore.

Del Rio, Tex.—The following proposals have been received by W. K. JONES, County Judge of Val Verde County: Berlin Iron Bridge Co., East Berlin, Conn., $3,984, $516: total, $4,500. Missouri Valley Bridge & Iron Works, Leavenworth, Kan., $4,236, $682; $5,078. King Iron Bridge & Mfg. Co., Cleveland, O., $4,430, $690; $5,120. Geo. E. King Bridge Co., Des Moines, Ia., $4,510, $636; $5,146. Penn Bridge Co., Beaver Falls, Pa., $4,620, $612; $5,232. Pittsburg Bridge Co., $4,910, $736; $5,646. Kansas City Bridge & Iron Works, $4,936, $715; $5,651. Milwaukee Bridge Co. (withdrawn). Iron Substructure Co., Columbus, O., $1,260, $992; $2,253 for iron substructure only. The contract was awarded to the Berlin Iron Bridge Co.

Bay City, Mich.—The proposal to build a bridge at Belinda St. has been indefinitely postponed.

La Crosse, Wis.—It has been voted to issue $85,000 in bonds towards the completion of the bridge.

St. Paul, Minn—The lowest bid received by Mr. RUNDLETT, City Engineer, for the Broadway Bridge, was from Kirkland & Starkey, of St. Paul, $86,594; the next was from McArthur Bros., of St. Paul, $90,978. The highest was $112,000.

Burlington, Ia.—Lyons and Burlington are talking of building pontoon bridges across the Mississippi next season.

St. Charles, Mo.—Work on the pontoon bridge across the Missouri will be commenced in February.

Atchison, Kan.—A new bridge across the Missouri is projected.

Portland, Ore.—A new bridge will be built across the Willamette River, for the Hawthorn Ave. and Woodstock electric lines. Including approaches it will be 2,270 ft. long, and will have 6 spans, besides a draw span 320 ft. long. Work will be begun at once, as the draw pier must be built during low water. It is expected that the structure will be completed by June.

The Needles, Cal.—Work is being pushed on the Atlantic & Pacific Ry. Co's. great cantilever bridge, which is to span the Colorado river nine miles below Needles. It will have a span of 660 ft.

St. Joseph's, Ont.—H. A. BARTON, WM. BARTON and G. P. CAMPBELL, of St. Joseph's Island, are interested in a project for a bridge to the mainland.

St. John, N. B.—Mr. F. W. HOLT, C. E., has prepared plans for a bridge to connect the eastern and western sides of the harbor. There will be two spans of 275 ft., one of 375 ft., five of 175 ft., two of 125 ft. and a trestle of 22 spans of 20 ft. across the island. There will be a roadway and a single track railway. Moving load, 4,000 lbs. per lin. ft. Estimates $247,270, $272,025, $321,425 and $450,000, according to modifications.

The Sabine Pass Channel Co. has elected the following officers at a recent meeting at Beaumont, Tex.: President, W. A. FETCHER, First Vice-President, H. J. LUTCHER; Second Vice-President, B. D. CRARY; Secretary, S. W. SWINFORD; Treasurer, L. B. PINKIN. The executive board are Messrs. H. J. LUTCHER and S. T. SWINFORD, of Orange; WM. WIESS and JOHN N. GILBERT, of Beaumont, and J. S. RICE, of Hyatt. Capital stock, $100,000

Viaducts.—***Jacksonville, Fla.***—An agreement has been made between the city and the railway companies for the construction of a viaduct over the railway tracks at Bridge and Commercial Streets. It will be an iron structure, with a roadway 60 ft. wide. Plans and specifications have been prepared by R. N. ELLIS, City Engineer.

Kansas City, Mo.—The Commercial Club has been considering a project for a viaduct to connect with Kansas City, Kan., and so avoid the numerous track crossings. Mayor HILLIKER, of Kansas City, Kan., is interested. The viaduct would be 3,000 ft. long and would cost about $250,000.

Canals.—***Cape Cod Ship.***—It is stated that a company representing several million dollars has been organized in New York to obtain, if possible, from Mr. F. A. LOCKWOOD, the present contractor, his entire rights in the enterprise.

Norfolk & North Carolina.—About $500,000 will at once be expended in improving the Dismal Swamp Canal, now the Norfolk and North Carolina Canal. Additional locks will be built, so as to allow vessels 250 ft. in length to pass through. It is also contemplated to build a fresh-water basin near Gilmerton locks for holding war vessels, as the company controls the fresh water supply from Lake Drummond. Mr. E. T. LYNCH, of New York, has been elected President of the company, and the capital stock is fixed at $1,000,000.

Beauharnois.—It has not been decided whether this Canadian Canal shall be enlarged or whether a new one shall be constructed on the north shore.

Cornwall Canal.—The contractors for the lower half of the canal, Wm. Davis & Sons, have suspended work for the winter after a fair season's work. A large number of piles have been driven for cofferdams and other purposes, two lock pits excavated, and the foundation and first course of masonry laid in one of them. Retaining walls have been started, and considerable crib-work done. Only one dredge has been at work last summer. The contractors expect to finish the three locks and most of the retaining walls early this year, and extra dredges will be put at the excavation.

ELECTRICAL.

Electric Lighting.—***Jamestown, N. Y.***—At a special election on Dec. 26 the city voted to issue bonds for $25,000 for an electric light plant. The local electric light company offered street lights at $72 per light per year.

Brooklyn, N. Y.—The Commissioner of City Works will open bids Jan. 6 for lighting the streets and public buildings.

Buffalo, N. Y.—The city of Buffalo has three systems of electric lighting, viz.: Brush, 600 lamps; Thomson-Houston, 365 lamps, and the United States, 159 lamps, a total of 1,233 lamps. Steam power is used by all of said companies. The lamps are nominal 2,000 c. p. and burn every night in the year, 3,951 hours per year. The city authorities asked for bids a few weeks since and received a uniform price of 42½ cts. per light per night.

Syracuse, N. Y.—Proposals for the 130 additional electric lights were opened recently and only two bids were received; one from the Syracuse Electric Light & Power Co. for 38½ cts. a night for each light, and the other from the Electric Construction Co. for 42½ cts. The bids were rejected.

Snow Hill, Md.—The Snow Hill Electric Light & Power Co., has been incorporated. President, J. P. MOORE.

Pulaski, Va.—Bond for electric lighting will be issued in March. For particulars address J. E. MOORE.

Paris, Ky.—An electric light company has been organized, with a capital stock of $60,000.

Warren, O.—A contract for lighting has been made with the Warren Electric Light Co.

Cincinnati, O.—The electric lighting contract has been awarded to the Brush Co. at $59.98 per lamp per year.

Detroit, Mich.—Proposals have been received by JOHN B. MOLONY, City Controller, as follows: Brush Electric Light Co., 141 towers, 565 arc lights, 147 post arc lights, and arc or incandescent lights for the public buildings, $136,440, $123,446, $107,854 for one, two, or three years; $5,300, $5,000, and $4,809 for the same terms for the public building separately. Edison Illuminating Co., $5,500 for three years for 450 incandescent lamps of 32 c. p. for three years. Detroit Electric Light & Power Co., $118,260.75, $107,9620.22, $98,541.50 per year for one, two, or three years; $1,000, $1,200, or $3,500 for public buildings.

East St. Louis, Ill.—The Citizens' Electric Light & Power Co. was incorporated two months ago, and commenced the construction of its buildings. The New Brighton Electric Light Co. has now been incorporated; President, P. W. ABT; Secretary, THOS. L. FEKETE Capital stock, $20,000. Neither company has a contract yet.

Marseilles, Ill.—The Marseilles Electric Light Co. has been incorporated by JAMES MONTGOMERY, JOSHUA SMITH, and J. F. CLARK. Capital stock, $30,000.

Rochester, Minn.—The new electric light plant has been completed. Light will be supplied for the streets and buildings. The plant was constructed and will be operated by the Northwestern Electric Supply Co., of St. Paul.

Argentine, Kan.—Arrangements are being made to establish an incandescent electric light plant in the new plant being built near the river. The plant will supply Argentine and Rosedale business houses with light.

Great Falls, Mont.—An electric light franchise has been granted to CHARLES O. PARSONS, of the Boston & Montana Co.

Belton, Tex.—The Belton Light & Water Co. proposes to put in a plant.

Electrical Companies.—At Syracuse, N. Y., the Electric Engineering & Supply Co., capital stock, $25,000, and the Central Electric Construction Co., capital stock, $100,000, have been organized by Messrs. MOFFETT, HODGKINS and CLARK.—The Thomson-Houston Electric Co. has increased its capital stock from $5,500,000 to $8,500,000.

SEWERAGE AND MUNICIPAL.

Sewers.—***Boston, Mass.***—An order has been passed requesting the mayor to petition the Legislature to allow the city of Boston to use $85,000 of a loan authorized for the extension of the improved sewerage system for the construction of a common sewer from Rosendale to West Roxbury, the same being the original intent.

Nashville, Tenn.—The City Engineer has prepared plans for a sewer 9 ft. diameter, 3,700 ft. long. Estimated cost, $60,000.

Florence, Ala.—Proposals are wanted for a system of sewerage. Address WADE ALLEN, Chairman of the Committee on Sewerage.

Key West, Fla.—Proposals will be received up to Feb. 1 for $500,000 bonds for sewers and paving. Address W. D. CASH, Chairman of the Finance Committee.

Cincinnati, O.—The Board of Public Affairs proposes to build a trunk sewer to drain Price Hill and Sedamsville.

Bakersfield, Ore.—A company has been organized to build sewers; the sewers will be of 8, 10 and 12-in. vitrified